ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA

A THESIS SUBMITTED TO

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT (PUNJAB)

IN THE PARTIAL FULFILLMENT

FOR THE AWARD OF DEGREE OF

DOCTOR OF MEDICINE

IN

RADIODIAGNOSIS

MAY 2022

Submitted By

DR MANPREET

DEPARTMENT OF RADIODIAGNOSIS
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA, PUNJAB

DECLARATION BY THE CANDIDATE

I hereby declare that the thesis entitled "**ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA**" submitted towards partial fulfillment of the requirements for the award of **MD in Radiodiagnosis** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Ritu Dhawan Galhotra**, Professor, Department of Radiodiagnosis, **Dr. Archana Ahluwalia**, Professor, Department Radiodiagnosis and **Dr. Rohit Verma,** Professor, Department of ENT. No part of this thesis has formed the basis for the award of any degree previously.

_____

DR. MANPREET
Department of Radiodiagnosis,
Dayanand Medical College & Hospital,
Ludhiana, Punjab

Date:

Place:

CERTIFICATE OF SUPERVISORS

This is to certify that the work incorporated in this thesis entitled "**ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA"** has been carried out by **Dr. Manpreet** under our direct supervision. The data incorporated in this thesis is original and genuine and has been carried out by the candidate herself.

Signature of Supervisor

Dr. Ritu Dhawan Galhotra
Professor
Department of Radiodiagnosis
DMC&H, Ludhiana

Signature of Co-Supervisors

Dr Archana Ahluwalia
Professor
Department of Radiodiagnosis
DMC&H, Ludhiana

Dr Rohit Verma
Professor
Department of ENT
DMC&H, Ludhiana

Date:

ENDORSEMENT BY THE HEAD OF THE INSTITUTE

This is to certify that the thesis entitled "**ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA"** is a bonafide research work done by **Dr Manpreet** under the supervision of **Dr. Ritu Dhawan Galhotra**, Professor, Department of Radiodiagnosis, **Dr. Archana Ahluwalia,** Professor, Department of Radiodiagnosis and **Dr. Rohit Verma**, Professor, Department of ENT in this institution.

Principal

Dr. Sandeep Puri
Principal
DMC&H, Ludhiana

Date:

COPYRIGHT

Declaration by the Candidate

I hereby declare that the Baba Farid University of Health Sciences, Faridkot, shall have the rights to preserve & use this thesis in print or electronic format for academic/study purpose by the research scholar/students.

Signature

Dr Manpreet
Department of Radiodiagnosis,
Dayanand Medical College & Hospital,
Ludhiana, Punjab - 141001

Date:

© Baba Farid University of Health Sciences, Faridkot

Dedicated

to

my Family,

friends

&

Teachers

ACKNOWLEDGEMENT

Words with all elaborations are not enough especially when it comes to the expression of feelings. It would take pages to acknowledge everyone who, in one way or the other has provided me with assistance, but certain individuals deserve citations for their valuable help.

First and foremost, I thank the Almighty who has always showered his blessings on me. My grandparents ***Late S. Ram Partap Singh*** *and* ***Late Smt Gurmail Kaur****, parents* ***S. Manjit Singh*** *and* ***Smt. Swaran Kaur****, always extended their unstinted support and assistance in every field of life. Without their moral support and help, I would not have been there where I am today.*

No words could express my feelings of acknowledgement for my guardian ***Smt. Charanjit Kaur*** *who has been my pillar of strength with her constant support and encouragement.*

Special thanks to my brother ***Dr. Davinder Singh*** *and* ***Dr. Jaskaran Singh*** *for always keeping me in high spirits.*

I do not have adequate words to express my sense of gratitude to my esteemed teacher and guide, ***Dr. Ritu Dhawan Galhotra****, Professor, Department of Radiodiagnosis, Dayanand Medical College and hospital, Ludhiana, for her ever-inspiring guidance and personal supervision. She was always there to steer me out of any difficult situation during my study. I feel privileged and honoured to work under such an illustrious guide and teacher.*

*I owe sincere thanks to **Dr. Kavita Saggar**, Professor and Head, Department of Radiodiagnosis, Dayanand Medical College and hospital, Ludhiana, with all my heart for her overwhelming support, ingenious suggestions, constructive criticism, and expert guidance throughout my post-graduation period.*

*I would extend special gratitude to my esteemed co-supervisors **Dr. Rohit Verma** , Professor , Department of ENT and **Dr. Archana Ahluwalia** , Professor, Department of Radiodiagnosis, Dayanand Medical College and hospital, Ludhiana, for their endless and consistent support and encouragement.*

*This piece of work would have been incomplete without the help and support of my respected teachers **Dr. Kamini Gupta**, **Dr. Siddharth Prakash**, **Dr. Chandan Kakkar** and **Dr. Satwant Singh** who encouraged me throughout my postgraduation period.*

*My sincere thanks to my teacher **Dr. Devinder Pal Singh Dhanota** for his invaluable contribution, constant help, advice, and continuous inspiration that led to the successful completion of this work and expert guidance throughout my post-graduation period.*

*I would like to thank my friends especially **Gaganjot Kaur Khosa , Dr. Astha Narula , Dr. Paramjeet Kaur Sethi, Dr. Anshul Kumar, Dr. Shaminder Dhillon, Dr Kapil Dev,***

Dr. Vijay Kumar and Dr Baljit Kaur *for helping me in my periods of distress throughout my postgraduation period.*

I would like to thank my seniors, batchmates and juniors, entire technical and official staff of the Department of Radiodiagnosis, DMCH Ludhiana who provided me with all the valuable help, guidance, and emotional support.

I am extremely thankful to all the patients who participated in this study. This project would have been unthinkable without their contribution.

I duly acknowledge and appreciate ***Ms. Neha Bhatt, Mr. Gurinder Singh, Mr. Tarun Sharma, Mr. Gurpreet Singh*** *and* ***Mrs. Namita Bansal*** *for their help, incredible display of patience in making this manuscript presentable.*

Dr. Manpreet.

ABBREVIATIONS

Ant crus	Anterior crus
CSOM	Chronic suppurative otitis media
CT	Computed tomography
COM	Chronic otitis media
CN	Cranial nerve
EAC	External auditory canal
HRCT	High resolution computed tomography
IAC	Internal auditory canal
J	jugular fossa
Jug	jugular vein
LSCC	Lateral semicircular canal
Long p.	Long process of incus
MRI	Magnetic resonance imaging
MSCT	Multispiral computed tomography
MPR	Multiplanar Reconstruction
MIP	Maximum intensity projection images
M	Mastoid
PSCC	Posterior semicircular canal
Post crus	Posterior crus
Pos	Petrooccipital synchondrosis
SSCC	Superior semicircular canal
TM	Tympanic membrane
VII1	labyrinthine part of facial nerve
VII2	tympanic segment of facial nerve
VII3	mastoid segment of facial nerve
Vest. aq.	vestibular aqueduct

ABSTRACT

Introduction: Chronic suppurative otitis media is persistent inflammation of a part or whole of middle ear cleft or mastoid cavity. It is characterised by recurrent or persistent ear discharge over 2-6 weeks. It is divided into two main clinical types: tubotympanic type (CSOM without cholesteatoma) and atticoantral type (CSOM with cholesteatoma).The diagnosis of middle ear cholesteatoma can be made by an otoscopic examination, endoscopic evaluation which can be confirmed by HRCT temporal bone that can delineate the anatomy of temporal bone ,ascertain the extent of the disease and bony erosions and determine its complications.

Aim of study: To evaluate the role of high resolution computed tomography (HRCT) temporal bone in patients with chronic suppurative otitis media (CSOM) & its correlation with the clinical / operative findings wherever possible.

Materials and methods: 50 clinically diagnosed or suspected patients with CSOM in Department of ENT,DMCH Ludhiana were referred to the Department of Radiodiagnosis ,DMCH Ludhiana for HRCT Temporal bone were the subjects of this study.Various observations were recorded as per the proforma and the findings were compared and correlated with the intraoperative findings wherever possible.

Results – Out of 50 diagnosed cases of CSOM,36(72%) patients had unilateral disease and 14(28%) had bilateral disease.Ear discharge was the most common presenting symptom seen in 89.1% patients followed by hearing loss in 75 % cases .Scutum(64.1%) was the most common site of bony erosions.The involvement of hidden areas such as sinus tympani and facial recess were well appreciated in HRCT. Incus(39.1%) was the most commonly eroded ossicle followed by malleus and stapes(20.3% each).15 out of 50 cases underwent surgical treatment and on correlating with intraoperative findings ,HRCT showed 100% sensitivity to detect soft tissue opacification of mesotympanum , hypotympanum , aditus ad antrum and mastoid air cells .The sensitivity and specificity to detect bony erosions involving tegmen tympani was 100% and 90.9% , scutum was 100% and 62.5 % , mastoid air cells was 100% and 100% , incus was 77.7% and 66.6% , malleus was 66.6% and 88.8% and stapes was 50% and 85.7% respectively.

Conclusion - HRCT is a valuable imaging modality in CSOM through which pre-operative assessment of extent of disease can be estimated with reasonable accuracy and helps the surgeon to convert a surgical exploration into a planned procedure.

Keywords:, high resolution computed tomography, chronic suppurative otitis media, intraoperative correlation.

TABLE OF CONTENTS

S. NO.	TOPIC	PAGES
I	INTRODUCTION	1-33
II	AIMS AND OBJECTIVES	34
III	REVIEW OF LITERATURE	35-42
IV	MATERIALS AND METHODS	43-44
V	OBSERVATIONS AND RESULTS	45-69
VI	DISCUSSION	70-77
VII	SUMMARY AND CONCLUSIONS	78-79
VIII	BIBLIOGRAPHY	80-87

APPENDICES – I

- PROFORMA
- MASTER CHART

APPENDICES – II

- APPROVAL LETTER OF THESIS PLAN
- THESIS PLAN

LIST OF TABLES

Table No.	Title	Page No.
1.	Distribution of cases according to age(n1=50)	46
2.	Distribution of cases according to gender(n1=50)	47
3.	Distribution of cases whether the disease is unilateral or bilateral(n1=50)	48
4.	Distribution of cases according to side affected (n2=64)	49
5.	Distribution of cases according to operative status (n2= 64).	50
6.	Distribution of cases according to symptoms of the patients (n2 =64)	51
7.	Distribution of the cases according to HRCT finding of soft tissue opacification (n2=64)	52
8.	Distribution of cases according to soft tissue opacification of the recesses on HRCT (n2=64)	54
9.	Distribution of the cases according to bony erosions on HRCT (n2=64)	55
10.	Distribution of the cases according to ossicular erosions on HRCT (n2=64)	57
11.	Distribution of cases according to complications of chronic suppurative otitis media on HRCT (n2=64)	58
12.	Correlation between HRCT and operative findings (n3=15)	60-61

LIST OF FIGURES

Figure No.	Title	Page No.
1.	Normal anatomy of ear.	7
2.	The temporal bone.	8
3	Relationships of the sinus tympani, facial recess, and facial canal within the posterior wall of the middle ear.	14
4	Ear ossicles and their parts.	16
5	Three-dimensional reformat of the ossicles.	17
6	Cut section of bony labyrinth.	21
7	Axial HRCT sections of right temporal bone along the axis of the cochlea.	23
8	Axial HRCT sections reformatted parallel to the lateral semicircular canal.	24
9	Coronal HRCT sections through the temporal bone from anteriorly to posteriorly.	25
10	Sagittal HRCT sections through the temporal bone.	26
11	Distribution of cases according to age (n1=50)	46
12	Distribution of cases according to gender (n1=50)	47
13	Distribution of cases whether the disease is unilateral or bilateral . (n1=50)	48
14	Distribution of cases according to side affected (n2=64)	49
15	Distribution of cases according to operative status (n2= 64).	50
16	Distribution of cases according to symptoms of the patients (n2 =64)	51

17	**Distribution of the cases according to HRCT finding of soft tissue opacification (n2=64)**	**53**
18	**Distribution of cases according to soft tissue opacification of the recesses on HRCT (n2=64)**	**54**
19	**Distribution of the cases according to bony erosions on HRCT (n2=64)**	**56**
20	**Distribution of the cases according to ossicular erosions on HRCT (n2=64)**	**57**
21	**Distribution of cases according to complications of chronic suppurative otitis media (n2=64)**	**59**

LIST OF PICTURES

Picture No.	Title	Page No.
1.	Chronic suppurative otomastoiditis without osscicular erosions.	62
2.	Cholesteatoma with bony erosions of tegmen tympani and tegmen mastoideum without ossicular erosions.	63
3.	Chronic suppurative otitis media with coalescent mastoiditis and osscicular erosions.	64
4.	CSOM with osscicular erosions and fistulous communication between mastoid and external auditory canal (automastoidectomy).	65
5.	Cholesteatoma with extensive bony erosions and skull base osteomyelitis and left side facial palsy.	66-67
6.	Chronic suppurative otomastoiditis with bony erosions and dehiscence of lateral semicircular canal.	68
7.	Chronic suppurative otitis media with bony erosions and external ear cholesteatoma	69

INTRODUCTION

The ear is an organ of special sense that has evolved from being an organ of balance to serving the complex and highly specialized function of hearing which is important for distant warning and communication. The ears are paired organs of sense, one on each side of the head, which is technically known as the cochlea, deeply buried within the temporal bones.[1]

It has an extremely complicated anatomy with minute structural components. The middle and inner ear are located in the petrous part of the temporal bone and its diseases have profound effect on hearing and balance.

Imaging of temporal bone previously was limited to plain radiography and multidirectional tomography. Plain radiographs are now almost completely obsolete except for the post-operative assessment of the position of the cochlear implant electrode array in the inner ear, which utilizes Stenver's or the Transorbital view. Poor spatial resolution makes it difficult to assess the minute bony erosions, therefore it is not a preferred imaging modality for temporal bone.

Imaging evaluation of the ear and temporal bone is primarily accomplished by computed tomography (CT) or magnetic resonance imaging (MRI). Each modality has its strengths and limitations. The patient's presenting symptoms and suspected diagnoses help guide the choice of modality. CT offers better spatial resolution compared to MRI [2]. CT allows excellent delineation of calcifications, cortical bone, air, and fat. In the temporal bone region, therefore, CT is useful for assessing the margin and patency of the external auditory canal (EAC); thickness of the tympanic membrane, as it is bordered on either side by air, and whether there may be myringosclerosis, perforation, or retraction; margins, aeration, and opacities of the middle ear; and bony and calcified structures such as the ossicles, mastoid septations, otic capsule, morphology and margins of the cochlea and semicircular canals, vestibular aqueduct, and facial nerve canal. MRI, on the other hand, offers much better, more specific, and more distinctive soft tissue characterization than CT [2]

HRCT has a very important role as it allows continuous rotation of gantry and therefore, continuous acquisition of image are taken. A block of thin sections (0.67mm thick) covering the entire temporal bone can be acquired in a single run. It helps in planning of surgical approach because it can display internal bony architecture of skull base and soft tissue pathology associated with it. It is widely used in diagnosis of inflammatory middle ear diseases, such as chronic otitis media or cholesteatoma and in evaluation of middle ear following mastoidectomy or tympanoplasty. [3,4]

Normally, middle ear cleft is lined by different types of epithelium in different regions: ciliated columnar in the anterior and inferior part, cuboidal in the middle part and pavement-like in the attic. The middle ear is nowhere lined by keratinizing squamous epithelium. It is the presence of latter type of epithelium in the middle ear or mastoid that constitutes a cholesteatoma. In other words, cholesteatoma is a “skin in the wrong place.” The term cholesteatoma is a misnomer because it neither contains cholesterol crystals nor it is a tumour to merit the suffix “oma.” However, the term has been retained because of its wider usage. Essentially, cholesteatoma consists of two parts: (i) the matrix, which is made up of keratinizing squamous epithelium resting on a thin stroma of fibrous tissues and (ii) a central white mass, consisting of keratin debris produced by the matrix . For this reason, it has also been named epidermosis or keratoma.[5]

The chronic serous otitis media is defined as an inflammatory process, infectious or not, focal or generalized in the middle ear. It is can be either tubotympanic (safe) or attrico-antral (unsafe) in location. CSOM is classified into two main clinical types: CSOM without cholesteatoma that is recognized clinically as safe type and CSOM with cholesteatoma, or unsafe type [6]. In the non-cholesteatomatous CSOM there are irreversible alterations in the middle ear epithelium that manifest as chronic otorrhea and perforation of the tympanic membrane, which requires surgical treatment for the disease control. The cholesteatomatous CSOM is defined as the presence of keratinized stratified squamous epithelium in any region of the middle

ear which may be acquired or more seldom congenital. Unsafe CSOM, especially those associated with cholesteatoma, require surgical treatment. The cholesteatoma have characteristics of growth, migration and osseous erosion and are thus locally destructive, the only treatment is their full surgical removal, since there is no effective clinical treatment for eradication of the disease so far. [7-9]

Initially clinical examination and audiology tests were performed in patients with temporal bone disease. When the clinical findings were merged with imaging findings, a reliable and accurate diagnosis was made, misinterpretations were avoided and appropriate treatment was ensured to the patient. [8]

HRCT temporal bone helps in diagnosing extent and sites of involvement of the disease in patients of CSOM. It is reliable to see parameters like ossicular chain erosion, scutum erosion, mastoid air cells pneumatization, low lying dura, cholesteatoma extension in facial recess, sinus tympani, cochlea, vestibule, external or internal auditory canal and the presence of complications like mastoiditis, facial canal dehiscence, sigmoid sinus plate erosion, lateral semicircular canal fistula and intracranial complications. Correlation between HRCT findings with intraoperative findings helps in better understanding of the disease process and guides appropriate surgical planning and treatment. However, CT has few limitations in evaluation of chronic middle ear disease. On CT scan, abnormal soft tissue densities are seen in chronically draining ears in the middle ear and mastoid. However, if bone erosion is not associated with soft tissue mass, it is not possible to discern whether or not cholesteatoma is present. Infrequently, the soft tissue masses were proved to be granulation tissue or mucosal hypertrophy. Abnormal soft tissue densities associated with bony erosion make the diagnosis of cholesteatoma definite. In developing countries like India, middle ear cleft infection and cholesteatoma is a big health burden with significant morbidity. Preoperative knowledge of chronic suppurative otitis media and its complications can guide the ideal approach for surgery by providing the extent of disease. It helps to prognosticate the patient regarding degree

of hearing attainable after surgery. Since a considerable number of patients with middle ear infections and/or with acquired cholesteatoma present in our hospital and there is paucity of available literature in Indian context, it was felt obligatory to study in detail the HRCT evaluation of chronic suppurative otitis media and its major complications

HISTORICAL REVIEW OF IMAGING

Medical imaging has experienced significant changes in both the technologic and clinical arenas since the discovery of X-ray in 1895 by Wilhelm Conrad Roentgen, a German Physicist. Innovations have become common in the Radiology Department. Today, the introduction of new ideas and methods and refinements in existing techniques, are apparent. One such development that is a revolutionary tool of medicine is computed tomography (CT). The word “tomography” was first used by Grossman in 1935 (from Greek, “tomos”, meaning “section”). A conventional tomogram is an image of a section of the patients that is oriented parallel to the film.

In 1937, Watson introduced tomographic technique in which the sections were transverse sections and this technique was referred to as transverse axial tomography. However these images lacked enough detail and clarity to be useful in diagnostic radiology. CT overcomes the limitations of tomography by using image reconstruction from projections to produce sharp and clear images.

In 1967, Dr. Godfrey Newbold Hounsfield applied the reconstruction techniques to produce the world’s first clinically useful CT scanner for imaging the brain.

In 1979, Hounsfield and Cormack shared the Nobel Prize in medicine and physiology, for their contributions to the development of CT.[10] Later, different generations (a term used to refer to the method of scanning) of CT scanners were introduced mainly to improve the image quality and to reduce the scan time.

In 1982, Shaffer and Turski described in detail the optimal technique for High Resolution Computed Tomography (HRCT). Gantry angulations for axial and coronal scans have been suggested for evaluating specific minute structures especially intratemporal structures.[11]

NORMAL ANATOMY OF THE TEMPORAL BONE

Embryology and Development:

The embryologic development of the ear is a multistage and anatomically complex process. The outer ear structures develop from the first branchial cleft and the first and second branchial arches during the 6th through 12th weeks of intrauterine life [12].

The external auditory canal (EAC) initially develops as a solid core of epithelium, termed the meatal plate, which migrates toward the first pharyngeal pouch and subsequently hollows out during the 2nd through 7th months of intrauterine life [12].

The eustachian tube and tympanic cavity arise from the first pharyngeal pouch between 10 and 30 weeks gestation [12].

The tympanic membrane is derived from three germ cell layers, including ectoderm from the first branchial groove and mesoderm and endoderm from the first branchial pouch [12].

The ossicular chain and supporting ligaments arise from the first and second branchial arches. The membranous portion of the inner ear arises from neuroectoderm (otic placode) in the 4th week of gestation. The otic placode invaginates, forming the otic pit, and subsequently forms the otic vesicle (otocyst) [12]. The otocyst divides into the dorsal and ventral pouches (pars superior and inferior, respectively), which are the precursors to the utricle, semicircular canals, cochlear duct, and saccule.

The bony labyrinth (otic capsule) develops from mesenchyme around the membranous labyrinth between 4 and 8 weeks gestation, continues to grow between 8 and 16 weeks gestation, and ossifies by the 24th week of gestation [12].

The inner ear development (vestibule, semicircular canals, internal auditory canal (IAC), cochlea) is independent of the middle ear (ossicles, mastoid antrum, tympanic membrane, middle ear air spaces) and external ear [external auditory canal (EAC), temporomandibular joint]structures. Therefore, middle ear and external ear deformities are usually not associated with developmental anomalies of inner ear and vice versa.

The external ear and middle ear develop from the first and second branchial arches. The inner ear development occurs from the ectodermal otocyst. The first branchial arch forms Meckel's cartilage, from which the head of the malleus and short process of the incus develop. The second branchial arch forms Reichert's cartilage, from which the remainder of the malleus and incus, styloid process, and stapes superstructure develop. The stapes footplate has a bilaminar composition, with an outer portion developing from Reichert's cartilage and an inner portion developing from the ectodermal otocyst. Until birth, the middle ear cavity and mastoid antrum are filled with fluid. The eustachian tube system and the middle ear are filled with air after the neonate's initial crying and breathing. The mastoid air cells develop as sac like extensions from the mastoid antrum, commencing at about the time of birth and continuing for several years. There is extensive variation in the degree of pneumatization. Incomplete pneumatization of the mastoid air cells may be caused by lack of proper function of the eustachian tube during early life.

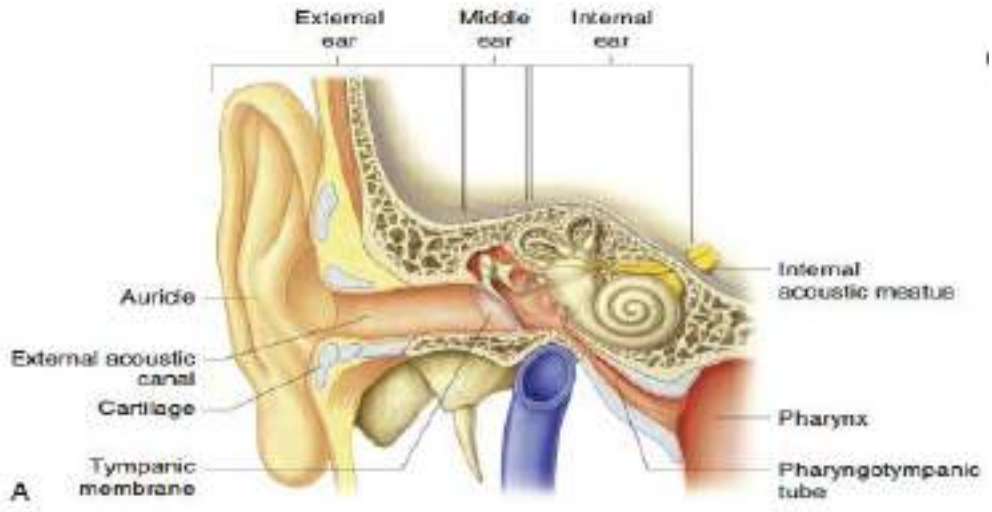


Figure 1. Normal anatomy of ear.[5]

NORMAL ANATOMY OF TEMPORAL BONE

The temporal bones comprise the lateral skull base, forming portions of the middle and posterior fossae. Each temporal bone is composed of five osseous parts:

1 .squamous

2. mastoid

3 petrous

4 tympanic

5 styloid portions.

Several intrinsic channels, intrinsic fissures, and extrinsic sutures are often apparent on CT images and can mimic fractures (pseudofractures) [13].

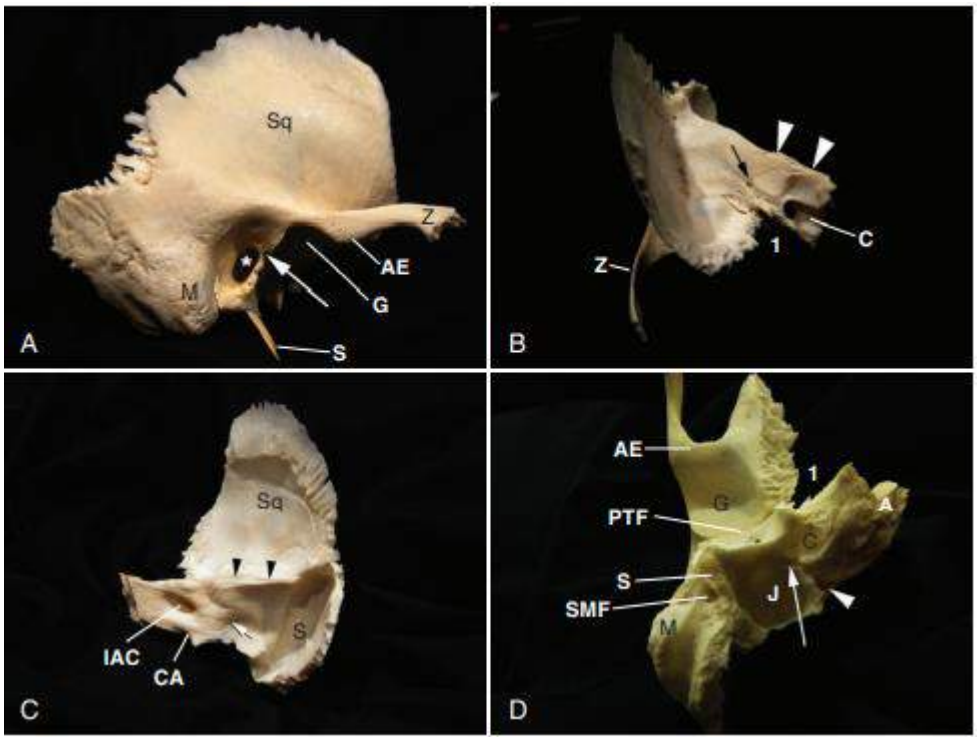


Figure 2. The temporal bone. A, Lateral view. The temporal bone articulates with the greater wing of the sphenoid anteriorly, the parietal bone superiorly, and the occipital bone posteriorly. Sq, squamous part; Z, zygomatic arch; AE, articular eminence; G, glenoid fossa; S, styloid process; M, mastoid tip; *, external auditory canal; arrow, glaserian fissure. B, View from superiorly and anteriorly. Z, zygomatic arch; C, opening of the carotid canal; arrowheads, groove for the superior petrosal sinus; arrow, facial hiatus; 1, notch for the greater wing of the

sphenoid. C, View from posteriorly. Sq, squamous part; IAC, porus acousticus and internal auditory canal; CA, pars nervosa and entrance to the cochlear aqueduct; arrow, opening of the vestibular aqueduct; arrowheads, groove for the superior petrosal sinus; S, groove for the sigmoid sinus. D, view from inferiorly. The styloid process (S) has been broken and is not visible. SMF, stylomastoid foramen; M, mastoid tip; J, jugular fossa; C, carotid canal entrance; arrowhead, pars nervosa and entrance to the cochlear aqueduct; arrow, inferior tympanic canaliculus; A, petrous apex; 1, notch for the greater wing of the sphenoid; AE, articular eminence; G, glenoid. The petrotympanic fissure (PTF) crosses the glenoid fossa. The medial part of the fissure is referred to the glaserian fissure.[14]

Squamous Portion

The squamous portion is composed of a flat plate of bone that forms the lateral wall of the middle cranial fossa and medial wall of the high masticator space. The outer surface is smooth and convex; it provides attachment to the temporalis muscle. A curved line (the temporal line) runs upward and backward along the posterior part, serving as an attachment for the temporalis fascia. The outer surface also demonstrates a vertical groove for the middle temporal artery. The squamous portion contributes to the posterior segment of the zygomatic arch and forms the anterior, or articular, portion of the mandibular fossa.

The mandibular fossa is bounded anteriorly by the articular tubercle and posteriorly by the tympanic part of the temporal bone, which separates it from the external acoustic meatus. The internal surface of the squamous temporal bone is concave and forms the lateral wall of the middle cranial fossa. It protects the lateral aspect of the temporal lobe of the brain. Branches of the middle meningeal vessels are related to the inner surface. Its superior border is formed by the squamosal suture, where it contacts the parietal bone. The anteroinferior border is thick and serrated; it articulates with the greater wing of the sphenoid.

Tympanic Portion

The tympanic portion is a U-shaped, curved bony plate that forms much of the external auditory canal (EAC) and the posterior (nonarticular) part of the glenoid fossa. It is located below the squamous portion and in front of the mastoid portion. The posterosuperior surface is concave, forming the anterior wall, the floor, and part of the posterior wall of the bony external acoustic meatus. The anteroinferior surface constitutes the posterior boundary of the mandibular fossa, and is related to the retromandibular part of the parotid gland. The lateral border is free and gives attachment to the cartilaginous part of the external acoustic meatus. The tympanic sulcus is located on its medial aspect, providing the attachment for the tympanic membrane.

Styloid Portion

The styloid process is a thin and pointed bony projection that extends inferiorly from the posterolateral aspect of the inferior surface of the petrous bone. The proximal part is ensheathed by the vaginal process of the tympanic portion and it is located at the anterior margin of the stylomastoid foramen.

Its distal part gives attachment to the stylohyoid and stylomandibular ligaments. In addition, the styloglossus, stylohyoideus, and stylopharyngeus muscles also have their origins from the distal part of the styloid process. The stylohyoid ligament extends from the apex of the process to the lesser cornu of the hyoid bone. It can be partially or completely ossified.

Mastoid Portion

The mastoid is a pneumatized, bulbous, bony process at the most posterior and inferior part of the temporal bone. It is somewhat triangular in shape, with the vertex directed inferiorly and the base superiorly. Anteriorly, the mastoid process forms the tympanomastoid suture as it joins the posterior portion of the tympanic bone. Above and lateral to the tympanomastoid suture is a variably sized suprameatal spine, an osseous elevation that anchors the nonosseous portion of the auricle to the EAC. The mastoid articulates with the parietal bone

superiorly and the occipital bone inferiorly, forming the parietomastoid and the occipitomastoid sutures. These two sutures join the occipitoparietal suture at a point called the asterion, an important surgical landmark for posterior fossa craniotomies. On the medial side of the mastoid tip is a deep groove, the mastoid notch, for the attachment of the digastric muscle, running from anterior to posterior. At its anterior termination, the sulcus serves as a landmark for the descending portion of the facial nerve and the stylomastoid foramen. The inner surface of the mastoid portion bears a curved groove, the sigmoid sulcus, which lodges part of the transverse sinus. This groove for the transverse sinus is separated from the innermost of the mastoid air cells by a very thin lamina of bone. The size of the mastoid is a reflection of its extent of the pneumatization. The degree of pneumatization can be extensive or minimal, depending on the genetic influences and presence of chronic infection during development. The air cells usually extend from the mastoid antrum to the mastoid tip, and occupy the retrofacial area and the perilabyrinthine region. The mastoid antrum is the largest and most constant air cell, located at the upper and front part of the bone. It opens anteriorly into the portion of the tympanic cavity that is known as the attic or epitympanic recess. The roof of the antrum is formed by a thin plate of bone called the tegmen mastoideum that separates it from the middle cranial fossa.

Petrous Portion

The petrous bone is a pyramid-shaped wedge of bone that forms the most medial aspect of the temporal bone. The petrous apex is directed medial, forward, and slightly cranial. Viewed from above and from inside the cranium, the base of the pyramid is the lateral surface that articulates with the squamous, tympanic, and mastoid portions of the temporal bone. The three sides of the pyramid are the superior surface that constitutes much of the floor of the middle cranial fossa, a medial surface that faces the posterior cranial fossa, and the inferior surface that articulates with the occipital bone posteriorly. The superior surface forms an important part of the middle cranial fossa floor. At its most anterior portion is the foramen lacerum, through which the internal

carotid artery passes at the end of its horizontal portion. Near its junction with the greater wing of the sphenoid is the foramen ovale where the third division of the trigeminal nerve (cranial nerve [CN] V3) exits the skull base entering the infratemporal fossa. The foramen spinosum is lateral and posterior to the foramen ovale and transmits the middle meningeal artery. A small impression of the superior semicircular canal, the arcuate eminence, can be usually seen along the superior surface. It is usually, but not always, elevated above the surrounding bone, the lateral portion of which forms the tegmen mastoideum and the tegmen tympani. The medial or cerebellar surface of the temporal bone forms the anterolateral wall of the posterior fossa. Near its center is a large orifice, the internal acoustic meatus (porus acusticus). It leads into a short canal, approximately 1 cm in length, which runs laterally. It transmits CNs VII and VIII. The meatus ends laterally at the medial wall of the vestibule and the inferior surface of the modiolus and basal cochlear turn. A horizontal bony ridge (crista falciformis) located at the lateral limit divides the meatus into two compartments, superior and inferior. The upper compartment is also divided into anterior and posterior portions by a small vertical bony crest commonly known as Bill's bar. These bony ridges divide the fundus of the internal auditory canal (IAC) into four quadrants, each carrying its own cranial nerve: the anterior-superior with the facial nerve, the anterior-inferior with the cochlear, and the posterior-superior and posterior-inferior quadrants occupied by the superior and inferior vestibular nerves, respectively. The inferior surface is irregular, and forms part of the undersurface of the base of the skull. The inferior surface articulates with the occipital bone forming the petro-occipital suture almost in continuity to the occipitomastoid suture. The jugular foramen is located here with its lateral margin formed by the petrous bone and its medial margin by the occipital bone. Immediately anterior to the jugular foramen is the petro-occipital sulcus, which contains the inferior petrosal sinus. In addition to the internal jugular vein, CNs IX, X, and XI also exit the cranial cavity by the jugular foramen. The cranial nerves are separated from the venous components by a dural septum

and fibrovascular tissue. Lateral and anterior to the anterior component of jugular foramen is the ascending portion of the carotid canal at the petrous portion's junction with the tympanic bone. [15-18]

External Ear

The external ear includes the auricle and external auditory canal (EAC), which extends laterally to the tympanic membrane. The tympanic membrane attaches to the tympanic annulus and measures approximately 10 mm in diameter. The normal tympanic membrane can often be faintly discerned on CT images. The lateral third of the EAC is fibrocartilagenous, while the medial two-thirds of the EAC is surrounded by the tympanic portion of the temporal bone. The anterior wall of the EAC also forms the posterior aspect of the glenoid fossa. The posterior wall of the EAC forms the anterior margin of the mastoid segment of the temporal bone and is resected during canal wall-down mastoidectomy.

Middle Ear

The middle ear together with the eustachian tube, aditus, antrum and mastoid air cells is called middle ear cleft. It is lined by mucous membrane and filled with air. The middle ear extends much beyond the limits of tympanic membrane which forms its lateral boundary. Middle ear can be likened to a six-sided box with a roof, a floor, medial, lateral, anterior and posterior walls.

Borders –

Superiorly- tegmen tympani

Laterally-tympanic membrane

Medially- otic capsule and cochlear promontory

Inferiorly-jugular floor

Roof - is formed by a thin plate of bone called tegmen tympani. It also extends posteriorly to form the roof of the aditus and antrum. It separates tympanic cavity from the middle cranial fossa.

Floor is also a thin plate of bone, which separates tympanic cavity from the jugular bulb. Sometimes, it is congenitally deficient and the jugular bulb may then project into the middle ear; separated from the cavity only by the mucosa.

The anterior wall has a thin plate of bone, which separates the cavity from internal carotid artery. It also has two openings; the lower one for the eustachian tube and the upper one for the canal of tensor tympani muscle.

The posterior wall - lies close to the mastoid air cells. It has the aditus ad antrum superiorly which joins the epitympanic recess to the mastoid antrum. The pyramidal eminence is a 'W' shaped elevation situated behind the oval window and gives origin to the stapedius muscle. It divides the posterior wall into two recesses.

1. The facial recess between pyramidal eminence medially and bony tympanic annulus laterally.
2. The sinus tympani between the labyrinthine wall medially and pyramidal eminence laterally.

Surgically, facial recess is important, as direct access can be made through this into the middle ear without disturbing posterior canal wall (intact canal wall technique).

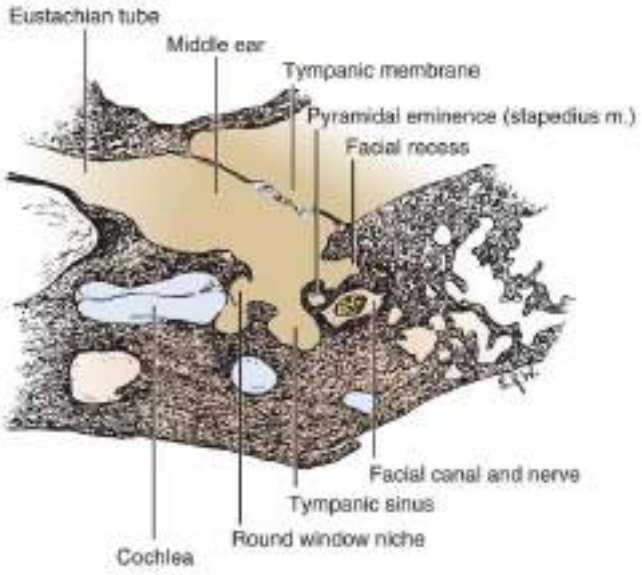


Figure 3 .Relationships of the sinus tympani, facial recess, and facial canal within the posterior wall of the middle ear. Axial section through the temporal bone at the level of the round window niche. These relationships are of paramount importance to the operating surgeon because they affect the surgeon's ability to gain access to diseased tissue. The tympanic sinus may be the site of occult disease. Primary facial nerve pathologic processes may also obliterate these

spaces. This minute anatomy is exquisitely defined on axial computed tomography (CT).[14]

The medial wall - is formed by the labyrinth. It presents a bulge called promontory which is due to the basal coil of cochlea; oval window into which is fixed the footplate of stapes; round window or the fenestra cochleae which is covered by the secondary tympanic membrane. Above the oval window is the canal for facial nerve. Its bony covering may sometimes be congenitally dehiscent and the nerve may lie exposed making it very vulnerable to injuries or infection. Above the canal for facial nerve is the prominence of lateral semicircular canal. Just anterior to the oval window, the medial wall presents a hook-like projection called processus cochleariformis. The tendon of tensor tympani takes a turn here to get attachment to the neck of malleus. The cochleariform process also marks the level of the genu of the facial nerve which is an important landmark for surgery of the facial nerve.

The lateral wall is formed largely by the tympanic membrane and to a lesser extent by the bony outer attic wall called scutum. The tympanic membrane is semitransparent and forms a “window” into the middle ear. It is possible to see some structures of the middle ear through the normal tympanic membrane, e.g. the long process of incus, incudostapedial joint and the round window.

Middle ear is divided into five spaces according to relationship to tympanic annulus –

Epitympanum (Attic) - superior to annulus. It has head of malleus and body of incus. It communicates with the mastoid via aditus.

Mesotympanum - on level with the pars tensa. It contains oval and round windows, handle of malleus, long process of incus, articulation with stapes and facial nerve in bony canal.

Hypotympanum – lies below annulus. It has the jugular bulb.

Protympanum – lies in the anterior recess of the middle ear. It contains the eustachian tube.

Retrotympanum – posterior to annulus. It contains sinus tympani, facial recess.

The contents of middle ear cavity are:

- Auditory ossicles
- Ligaments and muscles
- Facial nerve

Auditory ossicles - There are three ossicles in the middle ear—the malleus, incus and stapes.

Malleus has head, neck, handle (manubrium), a lateral and an anterior process. Head and neck of malleus lie in the attic. Manubrium is embedded in the fibrous layer of the tympanic membrane. The lateral process forms a knob-like projection on the outer surface of the tympanic membrane and gives attachment to the anterior and posterior malleal (malleolar) folds.

Incus has a body and a short process, both of which lie in the attic, and a long process which hangs vertically and attaches to the head of stapes.

Stapes has a head, neck, anterior and posterior crura, and a footplate. The footplate is held in the oval window by annular ligament.

The ossicles conduct sound energy from the tympanic membrane to the oval window and then to the inner ear fluid.

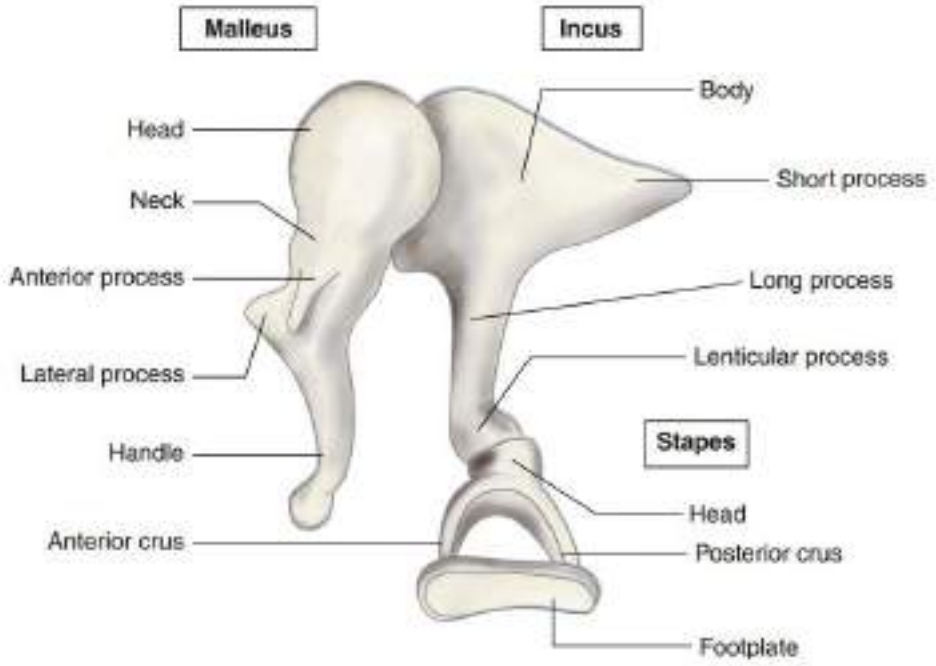


Figure 4. Ear ossicles and their parts.[5]

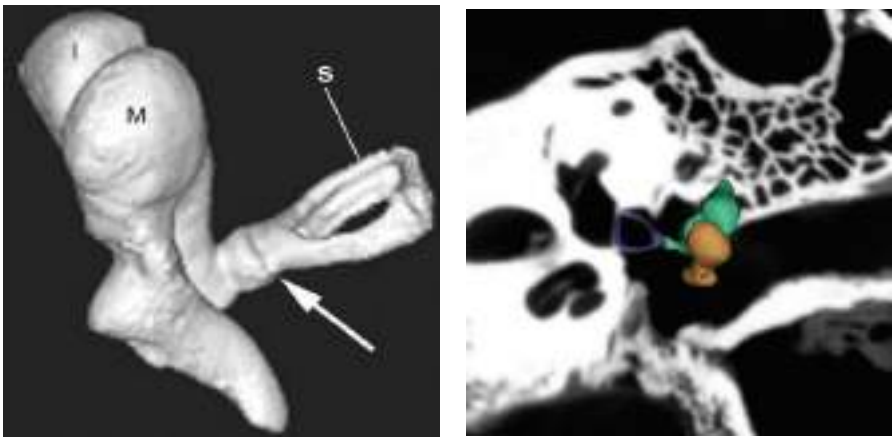


Figure 5. Three-dimensional reformat of the ossicles. M, the malleus; I, the incus; S, and stapes. The arrow in A indicates the incudostapedial joint.Three-dimensional reformat of the ossicles superimposed on an axial slice shows the relationship of the ossicles to the oval window and vestibule The malleus is orange, incus is green, and the stapes is blue.[14]

MASTOID ANTRUM

It is a large, air-containing space in the upper part of mastoid and communicates with the attic through the aditus. Its roof is formed by tegmen antri, which is a continuation of the tegmen tympani and separates it from the middle cranial fossa. The lateral wall of antrum is formed by a plate of bone which is on an average 1.5 cm thick in the adult. It is marked externally on the surface of mastoid by suprameatal (MacEwen's) triangle

ADITUS AD ANTRUM Aditus is an opening through which the attic communicates with the antrum. The bony prominence of the horizontal canal lies on its medial side while the fossa incudis, to which is attached the short process of incus, lies laterally. Facial nerve courses just below the aditus.

THE MASTOID AND ITS AIR CELL SYSTEM

The mastoid consists of bone cortex with a "honeycomb" of air cells underneath. Depending on development of air cell, three types of mastoid have been described.

1. Well-pneumatized or cellular. Mastoid cells are well developed and intervening septa are thin.

2. Diploetic. Mastoid consists of marrow spaces and a few air cells.

3. Sclerotic or acellular. There are no cells or marrow spaces.

INTRATYMPANIC MUSCLES

There are two muscles—tensor tympani and the stapedius; the former attaches to the neck of malleus and tenses the tympanic membrane while the latter attaches to the neck of stapes and helps to dampen very loud sounds thus preventing noise trauma to the inner ear. Stapedius is a second arch muscle and is supplied by a branch of CN VII while tensor tympani develops from the first arch and is supplied by a branch of mandibular nerve (V3). [5]

LINING OF THE MIDDLE EAR CLEFT

Mucous membrane of the nasopharynx is continuous with that of the middle ear, aditus, antrum and the mastoid air cells. It wraps the middle ear structures—the ossicles, muscles, ligaments and nerves—like peritoneum wraps various viscera in the abdomen—raising several folds and dividing the middle ear into various compartments. Middle ear contains nothing but the air; all the structures lie outside the mucous membrane. Histologically, the eustachian tube is lined by ciliated epithelium, which is pseudostratified columnar in the cartilaginous part, columnar in the bony part with several mucous glands in the submucosa. Tympanic cavity is lined by ciliated columnar epithelium in its anterior and inferior part which changes to cuboidal type in the posterior part. Epitympanum and mastoid air cells are lined by flat, nonciliated epithelium.

THE FACIAL NERVE: It emerges from the brainstem by a sensory and a motor root; leaving the brainstem at the inferior border of pons, medial to the VIIIth nerve. The intracranial segment is 23-25mm long. The internal auditory canal segment is 7-8mm and lies above the cochlear nerve. The labyrinthine segment is 3-4mm and passes forward and laterally in its bony canal (fallopian canal). At a point lateral to the cochlea, it angles forward perpendicular to the petrous to reach the geniculate ganglion. The direction of the nerve reverses at the level of ganglion. This is the first genu. The tympanic segment is 12mm long and passes posteriorly and laterally on the medial wall of the middle ear [19,20]. It lies below the bulge of the lateral semicircular canal and

above the oval window. At the level of sinus tympani the nerve assumes a vertical position known as the second genu of the facial nerve. It runs along the posterior wall of the tympanic cavity to exit at the base of the skull from the stylomastoid foramen. This mastoid segment is 15-20mm in length. The three branches of the facial nerve arising in the temporal bone are – • Greater superficial petrosal nerve arises at the geniculate ganglion and carries the secretomotor fibres to the lacrimal gland. • The nerve to the stapedius is given off in the mastoid course of the facial nerve behind the pyramid eminence. • The chorda tympani which is the special gustatory nerve to the anterior 2/3rd of tongue originates 5mm above the stylomastoid foramen.

The internal ear or the labyrinth - an important organ of hearing and balance. It consists of a bony and a membranous labyrinth. The membranous labyrinth is filled with a clear fluid called endolymph while the space between membranous and bony labyrinths is filled with perilymph.

BONY LABYRINTH

It consists of three parts: the vestibule, the semicircular canals and the cochlea.

1. Vestibule. It is the central chamber of the labyrinth. In its lateral wall lies the oval window. The inside of its medial wall presents two recesses, a spherical recess, which lodges the saccule, and an elliptical recess, which lodges the utricle. Below the elliptical recess is the opening of aqueduct of vestibule through which passes the endolymphatic duct. In the posterosuperior part of vestibule are the five openings of semicircular canals

2. Semicircular canals. They are three in number, the lateral, posterior and superior, and lie in planes at right angles to one another. Each canal has an ampullated end which opens independently into the vestibule and a nonampullated end. The nonampullated ends of posterior and superior canals unite to form a common channel called crus commune. Thus, the three canals open into the vestibule by five openings.

3. Cochlea. The bony cochlea is a coiled tube making 2.5 to 2.75 turns round a central pyramid of bone called modiolus. The base of modiolus is directed towards internal acoustic meatus and transmits vessels and nerves to the cochlea. Around the modiolus and winding spirally like the thread of a screw, is a thin plate of bone called osseous spiral lamina. It divides the bony cochlea incompletely and gives attachment to the basilar membrane. The bony bulge in the medial wall of middle ear, the promontory, is due to the basal coil of the cochlea.

The bony cochlea contains three compartments:

(a) Scala vestibuli

(b) Scala tympani

(c) Scala media or the membranous cochlea .

The scala vestibuli and scala tympani are filled with perilymph and communicate with each other at the apex of cochlea through an opening called helicotrema. Scala vestibuli is closed by the footplate of stapes which separates it from the air-filled middle ear. The scala tympani is closed by secondary tympanic membrane; it is also connected with the subarachnoid space through the aqueduct of cochlea [5]

MEMBRANOUS LABYRINTH

It consists of the cochlear duct, the utricle and saccule, the three semicircular ducts, and the endolymphatic duct and sac.

1. **Cochlear duct**- Also called membranous cochlea or the scala media. It is a blind coiled tube. It appears triangular on cross-section and its three walls are formed by: (a) the basilar membrane, which supports the organ of Corti; (b) the Reissner's membrane, which separates it from the scala vestibule; and (c) the stria vascularis, which contains vascular epithelium and is concerned with secretion of endolymph. Cochlear duct is connected to the saccule by ductus reuniens . The length of basilar membrane increases as we proceed from the basal coil to the apical coil. It is for this reason that higher frequencies of sound are heard at the basal coil while lower ones are heard at the apical coil.

2. **Utricle and saccule**. The utricle lies in the posterior part of bony vestibule. It receives the five openings of the three semicircular ducts. It is also connected to the saccule through utriculosaccular duct. The sensory epithelium of the utricle is called macula and is concerned with linear acceleration and deceleration. The saccule also lies in the bony vestibule, anterior to the utricle and opposite the stapes footplate. Its sensory epithelium is also called macula. Its exact function is not known. It probably also responds to linear acceleration and deceleration.

3. **Semicircular ducts.** They are three in number and correspond exactly to the three bony canals. They open in the utricle. The ampullated end of each duct contains a thickened ridge of neuroepithelium called crista ampullaris.

4. **Endolymphatic duct and sac**. Endolymphatic duct is formed by the union of two ducts, one each from the saccule and the utricle. It passes through the vestibular aqueduct. Its terminal part is dilated to form endolymphatic sac, which lies between the two layers of dura on the posterior surface of the petrous bone. [5]

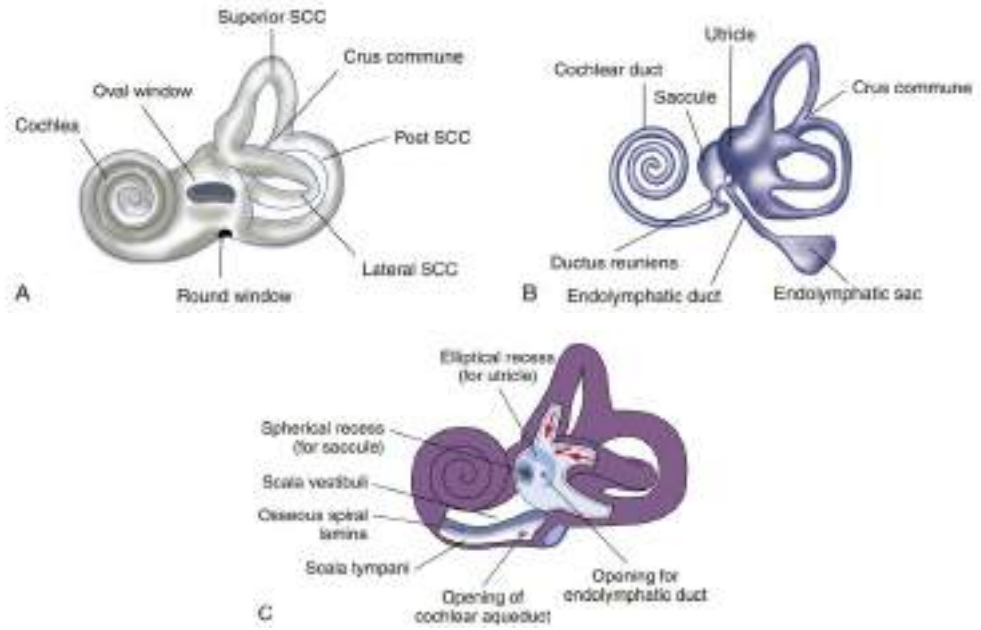


Figure 6. (A) Left bony labyrinth. (B) Left membranous labyrinth. (C) Cut section of bony labyrinth.[5]

INNER EAR FLUIDS AND THEIR CIRCULATION

There are two main fluids in the inner ear: perilymph and endolymph.

1. **Perilymph** resembles extracellular fluid and is rich in Na ions. It fills the space between the bony and the membranous labyrinth. It communicates with CSF through the aqueduct of cochlea which opens into the scala tympani near the round window.

2. **Endolymph** fills the entire membranous labyrinth and resembles intracellular fluid, being rich in K ions. It is secreted by the secretory cells of the stria vascularis of the cochlea and by the dark cells (present in the utricle and also near the ampullated ends of semicircular ducts).[5]

NORMAL HRCT ANATOMY OF TEMPORAL BONE

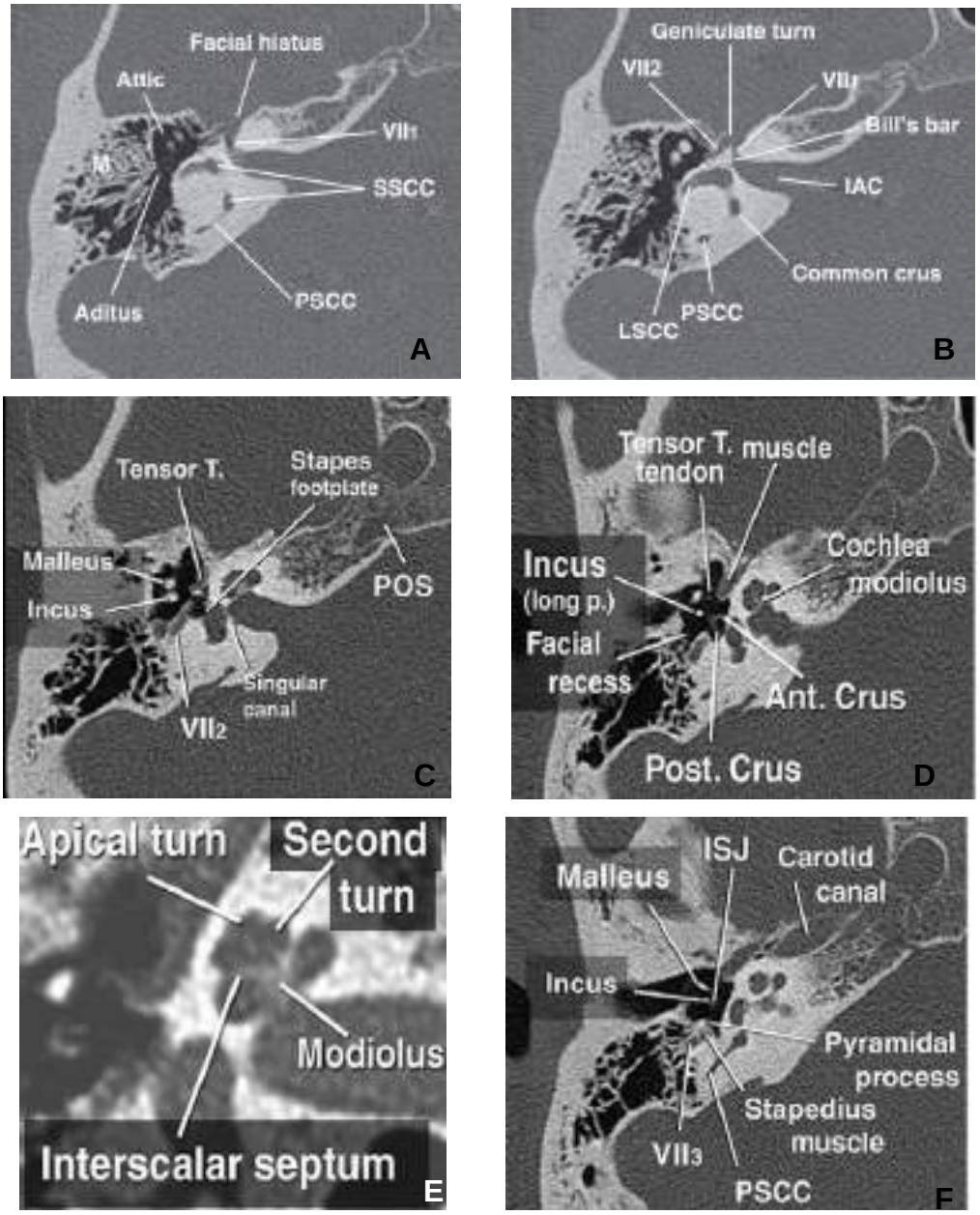


Figure 7. Axial HRCT sections(A to I) of right temporal bone along the axis of the cochlea. At level A, the labyrinthine segment of the facial nerve canal courses from the internal auditory canal toward the geniculate turn of the facial nerve. The tympanic segment then passes posteriorly along the medial wall of the middle ear (A, B &C). Just below the level of scutum, the neck of the malleus and the lower portion of the body of the incus (and/or the uppermost portion of the long process of the incus) are seen as two “dots” (section C). At level D & E, both crura of the stapes are seen, and the inner architecture of the cochlea can be appreciated. When the manubrium of the malleus and

the long process of the incus are seen as two roughly parallel lines (F), the scan plane is in the mesotympanum .Mastoid(M), petrooccipital synchondrosis(POS), lateral semicircular canal (LSCC), posterior semicircular canal(PSCC) ;, internal auditory canal (IAC) , Incudostapedial joint(ISJ),labyrinthine part of facial nerve (VII1), tympanic segment of facial nerve(VII2), mastoid segment of facial nerve (VII3) [14]

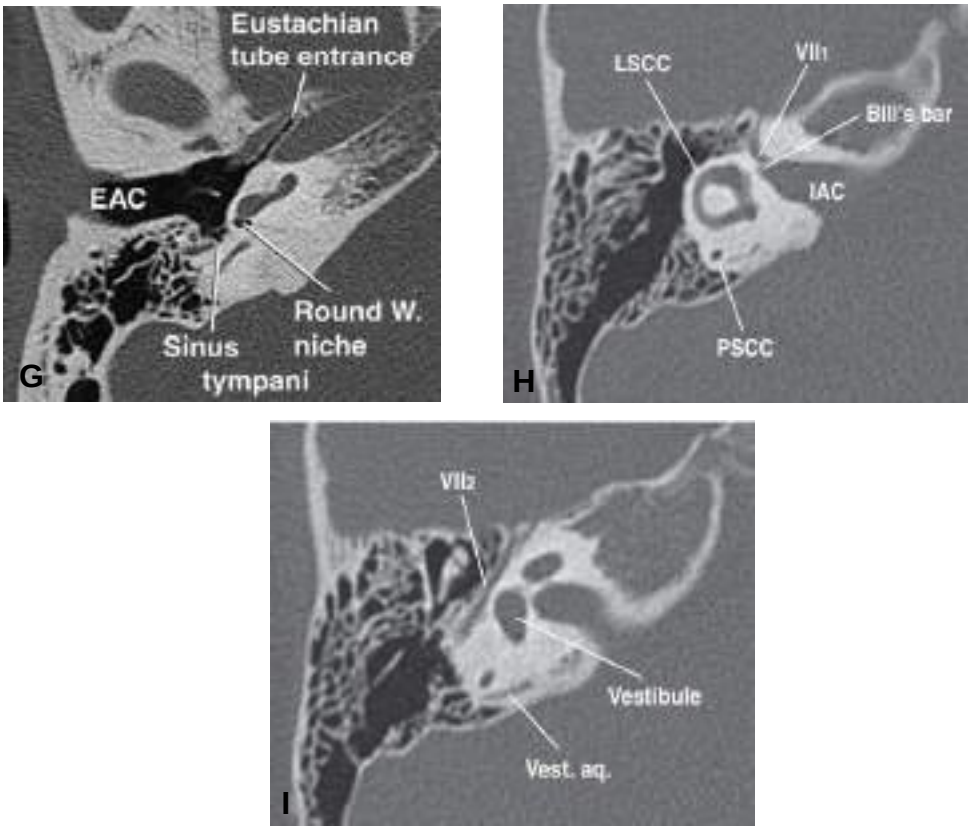


Figure 8 Axial HRCT sections (G,H & I) reformatted parallel to the lateral semicircular canal(H&I). Anterior epitympanic recess and sinus tympani (visualised in G). Connecting the anterior and posterior limbs of the lateral semicircular canal allows the plane to pass directly along the arc of the canal. H, This allows visualization of the cortical plate of bone along the outer curve of the canal (seen in H). Most of the tympanic segment of the seventh cranial nerve (VII2) is seen just inferior to the lateral semicircular canal (LSCC) (seen in I). posterior semicircular canal(PSCC),internal auditory canal (IAC), vestibular aqueduct(Vest. aq.) ,Round window (W), labyrinthine part of facial nerve (VII1), tympanic segment of facial nerve(VII2) [14]

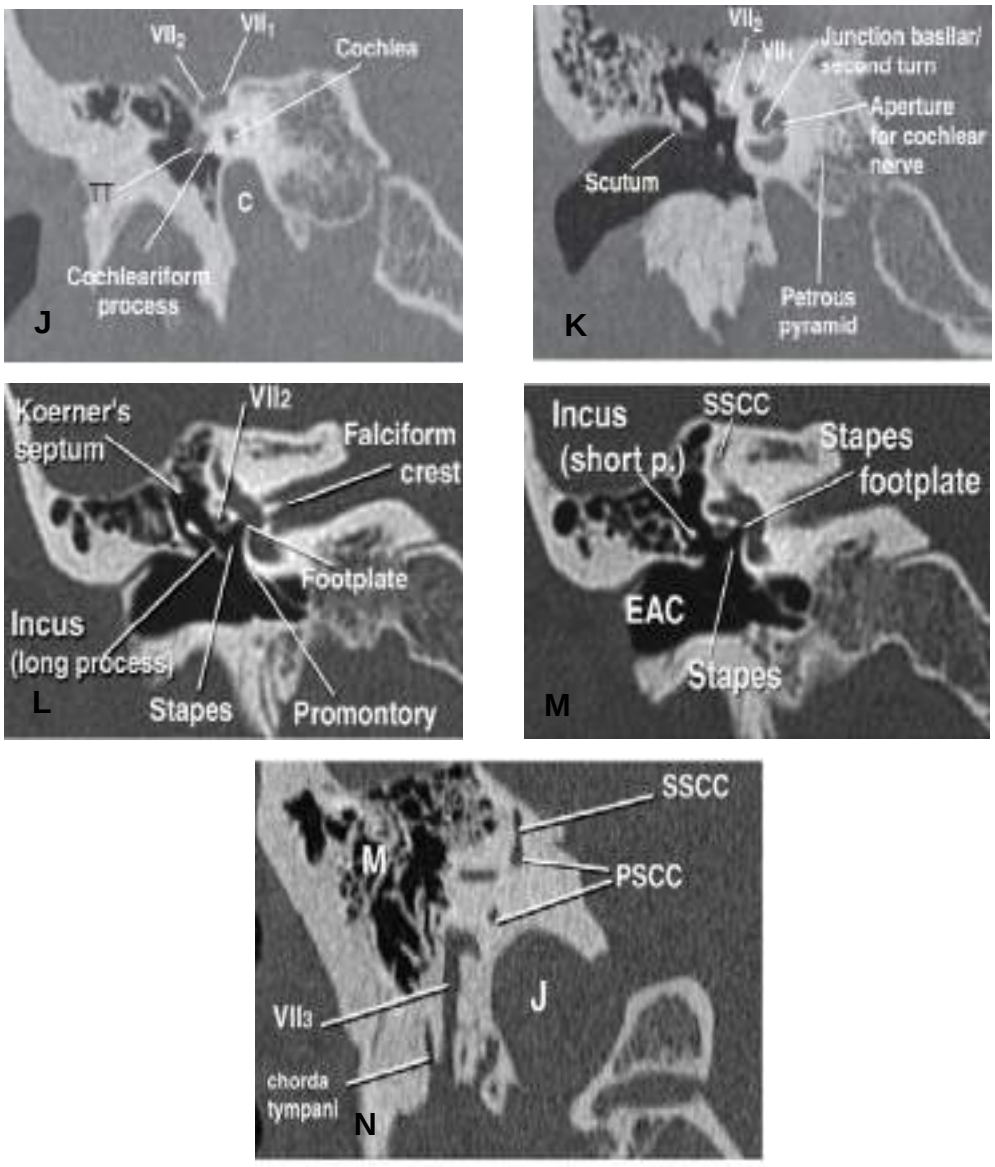


Figure 9. Coronal HRCT sections (J,K,L,M& N) through the temporal bone from anteriorly to posteriorly. The tympanic segment of the facial nerve canal courses under the lateral semicircular canal and over the stapes and oval window (at the level of L) before turning inferiorly. The entire course of the mastoid (vertical) segment of the facial nerve canal is seen at level N. Tensor tympani (TT), carotid artery within the carotid canal (C), Mastoid (M),). ,labyrinthine part of facial nerve (VII1), tympanic segment of facial nerve(VII2), mastoid segment of facial nerve (VII3) [14]

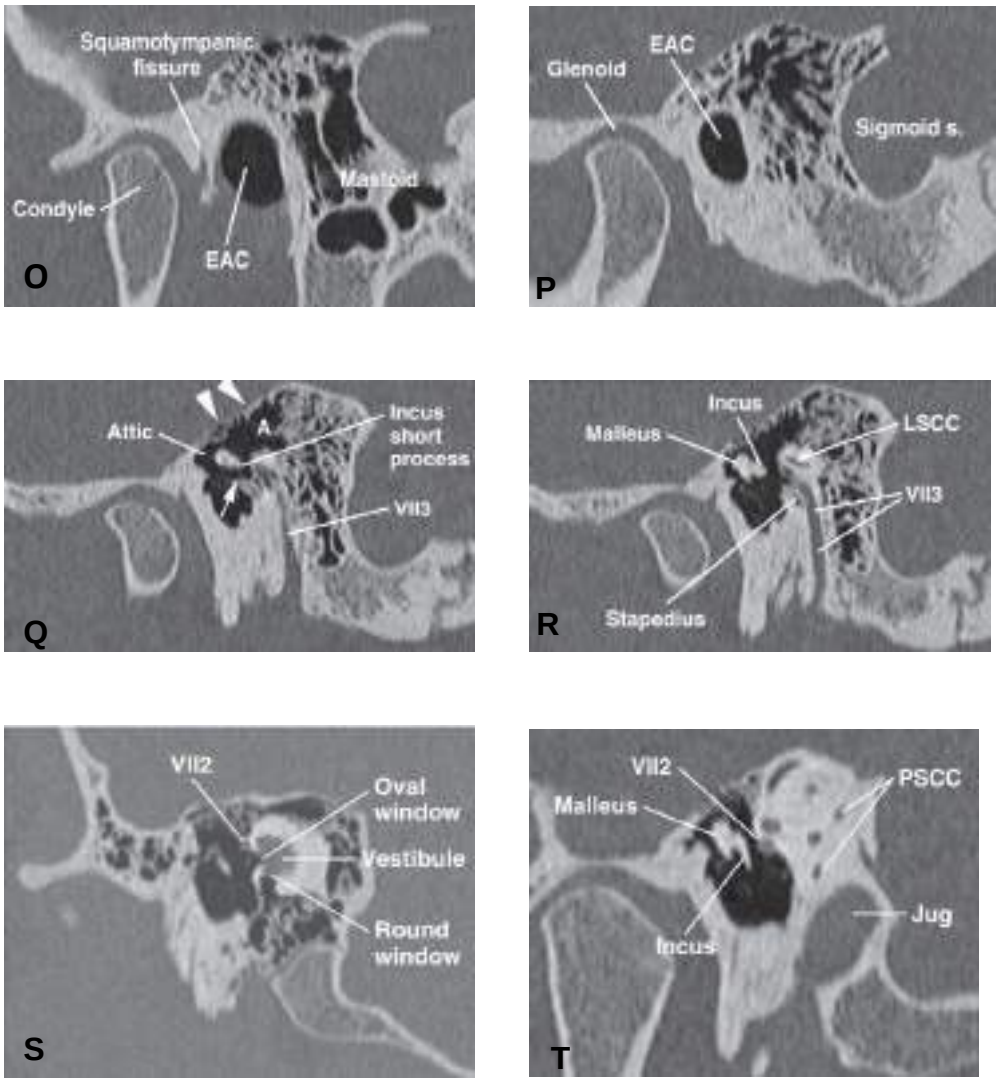


Figure 10 . Sagittal HRCT sections (O to T) through the temporal bone.. The images are done sequentially from laterally to medially through the left temporal bone. The external auditory canal is seen in cross section in the most lateral images (O and P). The facial nerve canal mastoid (vertical) segment is seen in T. The stapedius muscle is seen within the pyramidal process at the same level. The oval and round windows are seen in S.External auditory canal (EAC),Sigmoid sinus (sigmoid S), antrum(A), lateral semicircular canal(LSCC), superior semicircular canal(SSCC), posterior semicircular canal (PSCC), jugular vein(Jug), tympanic segment of facial nerve(VII2), mastoid segment of facial nerve (VII3). [14]

INFLAMMATORY DISEASES OF MIDDLE EAR.

The basic pathology of middle ear inflammatory disease is eustachian tube dysfunction. This may manifest as:

1. **Secretory otitis media** - defined as persistent mucoid or serous middle ear effusion, in the absence of acute inflammation secondary to eustachian tube dysfunction [21,22]. It is the most common disease in children. Symptoms include fluid filling the middle ear cavity causes tympanic membrane bulging with no signs of acute infection (redness, pain, oedema). Over time, middle ear fluid can become very thick and glue-like ("glue ear"), which increases the likelihood of conductive hearing loss. Imaging findings - Middle ear cavity and mastoid air cells are completely, homogeneously opacified. There is no ossicular chain erosion .
2. **Acute otitis media and mastoiditis**: usually presenting with typical clinical image and in most cases not requiring imaging. Symptoms include earache, fever, pain, otorrhea, conductive hearing loss. On otoscopy tympanic membrane is red and bulging [23,24]. HRCT in acute condition may show non specific debris in the middle ear and mastoid, possibly with fluid levels. The integrity of ossicular chain, mastoid septae, external and internal mastoid cortices is preserved. It is usually a clinical diagnosis.

Complications of acute otitis media and mastoiditis:

a) **Coalescent mastoiditis**: CT will show erosion of the mastoid septae with associated development of intramastoid empyema. The outer cortex also needs to be evaluated as there may be a subperiosteal abscess in the postauricular region.

b) **Dural sinus thrombosis**: A clot may be seen as a filling defect in the dural venous
sinus (empty delta sign) on CECT.

c) **Venous infarct**: Thrombophlebitis of sigmoid and transverse regions may propagate retrograde into superior sagittal sinus, leading to venous outflow obstruction and venous hypertension which can lead to cerebral edema, infarction and hemorrhage.

d) **Abscess/meningitis**: Brain abscess usually occurs in temporal lobe and cerebellum.

e) **Hydrocephalus**

3. Chronic suppurative otitis media: CSOM is a sequela of unresolved acute otitis media.It is characterised by recurrent or persistent ear discharge (otorrhoea) over 2-6 weeks. [25]. The chronological distinction between acute and chronic otitis media is variable; however, as per WHO definition, CSOM is defined by the persistence of otorrhea beyond 2 weeks. It is the most common granulomatous condition of the middle ear and mastoid air cells. It is histopathologically characterized by advanced, irreversible mucosal changes [26]. Its permanent nature, resistance to conservative management and relentlessly dragging evolution differentiates it from simple AOM. If unhalted, it may lead to sclerotic-adhesive sequelae or life-threatening complications [26,27].

Clinically, CSOM is categorized into the following 2 types:

A. **Tubotympanic (safe type)** – there is central perforation of the tympanic membrane (TM), and the inflammatory process is restricted to the middle ear mucosa. HRCT reveals opacification of the middle ear cavity without erosion of the bone or ear ossicles .

B. **Attico-antral (unsafe type**) – marginal or attic type of TM perforation and involvement of the periosteum leads to bone erosions [28]. From the imaging perspective, atticoantral CSOM can be further classified into cholesteatomatous or non-cholesteatomatous types. In both these subtypes, granulation tissue is present; however, cholesteatoma characteristically leads to bone and ossicular erosion (in ~90% of the cases) [28,29]

The classical HRCT findings in attico-antral CSOM with cholesteatoma include

1) erosion and blunting of scutum (lateral attic wall),

2) widening of the aditus ad antrum,

3) displacement of ossicular chain and

4) destruction of ear ossicles [27-29].

CSOM can manifest as

a) **Middle ear effusions**: These are diagnosed on CT by the presence of radiodensity in an incompletely opaque middle ear.[30]

b**) Granulation tissue**: It is the closest mimic of cholesteatoma. Tympanic membrane is intact in the presence of granulation tissue while in cholesteatoma its is either perforated or retraction pocket is present . Granulation tissue cause no significant hearing loss while cholesteatoma causes hearing loss . Bony erosions is not a feature of granulation tissue while in cholesteatoma bony erosions are present .

c) **Tympanic membrane retractions**: Reduced intratympanic pressure may pull the tympanic membrane medially. It is known as tympanic membrane retraction. It can be in pars tensa, pars flaccida or both. Pars flaccida retractions are difficult to assess by otoscopy.

d**) Cholesteatoma**: It is a sac lined by trapped keratinizing stratified squamous epithelium growing in the middle ear space and is classically described as “skin in wrong place”. CT appearance is a non-dependent, homogenous, soft tissue mass in the middle ear cleft. [31- 35] Cholesteatoma can be congenital or acquired which may be distinguished based on the history, status of the TM and location of the lesion [36-38]. Congenital cholesteatoma (CC) develops from the embryonic epithelial rest which is most commonly located in the temporal bone but can be present elsewhere in the skull, including skin [36,39]. Unlike the acquired type, CC is not a sequelae of CSOM; nonetheless, it needs to be mentioned due to similar imaging findings [40,41]. On the other hand, acquired cholesteatoma can be primary or secondary, depending on the integrity of TM. In primary acquired cholesteatoma, TM is intact, whereas in the secondary type, there is epithelialization of the middle ear across the ruptured TM. Of its various subtypes, the incidence of primary acquired cholesteatoma is the highest (80%), followed by secondary acquired (18%) and congenital (2%) types [27].

When evaluating CT images for the presence of cholesteatoma, the following features should be addressed:

- Ossicle erosion and displacement
- Bony cover of tegmen tympani and lateral semicircular canal
- Bony walls of tympanic segment and anterior genu of the facial nerve
- Possible extension of cholesteatoma towards sinus tympani (since it correlates with high post-surgical recurrence rate)
- Involvement of hidden area, mastoid air cell system.
- Possible involvement of oval window niche [42,43]

HRCT features of cholesteatoma:

1. Nondependent soft tissue density
2. Hypo pneumatization of mastoid
3. Specific site localization- Prussack's space, anterior epitympanic recess Posterior recesses- facial recess and sinus tympani
4. Adjoining bony erosions- chiefly scutum, ossicles, facial nerve canal involvement, tegmen tympani erosion, sigmoid plate erosion and Lateral semicircular canal dehiscence.

Acquired cholesteatomas are either present in pars tensa or pars flaccida:

Pars flaccida – It is the primary acquired cholesteatoma which begin in Prussack's space (epitympanum)with medial displacement of ossicles. They extend posteriorly into the attic and inferiorly into the posterior tympanic recesses. Upper 1/3rd part of tympanic membrane is involved.

Pars tensa – it is the secondary acquired cholesteatoma in which the disease begins in the posterior tympanic recesses. They are called sinus cholesteatomas. The ossicular chain is displaced laterally. Lower 2/3rd part of tympanic membrane is involved.[28,36,42]

e) Tympanosclerosis: Is an end result of chronic inflammation of the middle ear. It results in ossicular fixation and calcification which can be seen on CT.

Complications of cholesteatomas: broadly classified into 2 categories, as intra- or extratemporal. Intratemporal complications are further divided into extracranial and intracranial **.**

Intratemporal extracranial complications :

- Ossicular erosions
- Labyrinthine fistula
- Facial nerve paralysis and canal dehiscence .
- Post inflammatory ossicular fixation (PIOF)
- Petrous apicitis
- Mastoiditis (coalescent, sclerosing)

Intratemporal intracranial complications :

- Meningitis
- Dural venous sinus thrombosis
- Epidural abscess
- Otitic hydrocephalus
- Meningo or encephalocele
- Brain abscess

Extratemporal extracranial complications

- Subperiosteal abscess
- Bezold's abscess

1) **Ossicular erosion**: The long process of incus is usually involved early followed by involvement of the body of incus and head of malleus. It can also lead to erosion of scutum, tegmen tympani, bony labyrinth (lateral semicircular canal) and facial nerve canal (tympanic segment). Scutum erosion is classically seen in the attic cholesteatoma The recommended window settings for the optimal assessment of ear ossicles include a large window width (e.g. 4000 HU) and a low window level (0–200 HU) [27]
2) **Labyrinthine fistula**: Common site is lateral semicircular canal followed by superior ampulla, posterior canal and cochlear promontory.[43]
3) **Facial nerve palsy and canal dehiscence:** It occurs commonly in the tympanic segment of facial nerve as it is in close approximation to epitympanum which is common site of cholesteatoma. Diagnostic uncertainties may arise when there is congenital dehiscence or thinning of the bony canal, which may be indistinguishable from subtle erosions [44]

4) **Post-inflammatory ossicular fixation (PIOF)** is one of the causes of conductive hearing loss in CSOM. There are three subtypes of PIOF, representing the histopathological continuum from fibrosis to calcification

a. Fibrous tissue fixation (chronic adhesive OM) – most common;

b. Collagen hyalinization (tympanosclerosis);

c. New bone formation (fibroosseous sclerosis).

HRCT is the modality of choice in suspected PIOF, irrespective of the pathological subtype.[43]

5) **Petrous apicitis** The petrous apex is the anteromedial portion of the temporal bone and is pneumatized in ~30% of the general population. A pneumatized petrous apex freely communicates with the tympanic cavity and the mastoid air cells. Accordingly, CSOM may involve the pneumatized petrous apex leading to petrous apicitis. Clinically, patients may present with Gradenigo's syndrome (triad of retro-orbital pain, aural discharge and sixth nerve palsy). Due to its location, an involvement of the petrous apex is of utmost clinical concern, as it may further spread to the middle and posterior cranial fossa. On HRCT, there is opacification of the pneumatized petrous apex [45,46].

6) **Intracranial complications**: Arise due to erosion of sigmoid and tegmen plate. [44-49]These include:

a) **Meningitis** - is the most common intracranial complication

b) **Dural venous sinus thrombosis** - Sigmoid sinus thrombosis either by direct spread of infection or from retrograde transmission through emissary vein.

c) **Intracranial epidural abscesses** involving temporal lobe and cerebellum

d) **Otic hydrocephalus**. [47,48]

e **) Meningo- or encephalocele** is a rare complication resulting from the erosion of tegmen tympani or sinus plate, leading to herniation of the meninges or brain[44]

7) **Subperiosteal abscesses** result from the cortical breach leading to further spread of the inflammatory processes underneath an intact periosteum.

8) **Bezold's abscess** occurs due to erosion of the mastoid tip with consequent spread of phlegmonous debris in the soft tissue of the neck[49].

AIMS AND OBJECTIVES

To evaluate the role of high resolution computed tomography (HRCT) temporal bone in patients with chronic suppurative otitis media (CSOM) and its correlation with the clinical / operative findings wherever possible.

REVIEW OF LITERATURE

Gerami H et al (2009) did a study to compare the consistency rates of pre- and intra-operative radiological findings in patients with chronic suppurative otitis media (CSOM). They concluded that preoperative CT scan may be helpful in decision-making for surgery in cases of cholesteatoma and ossicular erosion and despite of limitations radiological scanning it is a useful adjunct to management of CSOM.[50]

Alzoubi FQ et al (2009) did a study and analyzed the clinical presentation and checked if CT scan confirmed or excluded the presence of cholesteatoma and if this was affected by previous surgery. They concluded that CT scan could not be relied on to differentiate cholesteatoma from chronic mucosal disease and it should be used selectively in the preoperative preparation only if complications of the disease suspected. [51]

Dobrotin VE et al (2009) did a study examining utility of the data obtained by multispiral computed tomography (MSCT) for the choice of surgical techniques is discussed with special reference to chronic suppurative otitis media and concluded that the intraoperative findings were in excellent agreement with MSCT data.[52]

Sethom A et al (2011) did a study to compare preoperativeCT scan finding and per-operative lesions in patients operated for middle ear cholesteatoma. They concluded that preoperative computed tomography is necessary for the diagnosis and the evaluation of chronic middle ear cholesteatoma in order to show extending lesion and to detect complications and that CT analysis and surgical correlation have showed that sensibility, specificity and predictive value of CT-scan depend on the anatomic structure implicated in cholesteatoma damages.[53]

Sun XV et al (2011) did a study to evaluate the efficacy of high-resolution CT (HRCT) in differential diagnosis and treatment of chronic suppurative otitis media and cholesteatoma by soft-tissue shadows. They concluded that combination of the three different imaging methods, axial images, coronal MPR (multiplanar reconstruction) images and MIP (maximum intensity projection) images, can improve

the efficacy of the HRCT diagnosis and definite chronic otitis media, which can be routinely used for surgery plan.[54]

Tatlipinar A et al (2012) did a study to determine the role of high-definition computed tomography (CT) in chronic otitis media (COM) patients and to present which parameters were useful or misleading for preoperative evaluation for management. They found out that CT could not detect dehiscence of facial canal, lateral semicircular canal, and tegmen successfully. Based on their results, they concluded that CT scanning has limitations but is a useful adjunct for the surgical management of COM patients.[55]

Yildirim-Baylan M et al (2012) did a study aimed to compare the veracity of computed tomography findings on patients undergoing surgery for chronic otitis media (COM) with the surgical findings, and to determine to what extent the preoperative computerized tomography (CT) findings are useful to the surgeon. They concluded that preoperative computed tomography evaluation is fairly useful especially in cases of cholesteatoma. According to the results of their study, CT is of value particularly in the definition of cholesteatoma, and in determining ossicular chain erosion and semicircular canal fistula.[56]

Sonika Kaotra et al (2013) did a study on 47 patients with active squamosal COM underwent preoperative HRCT temporal bone followed by surgery and found that HRCT was highly sensitive for detecting mastoid pneumatization, soft tissue extension, ossicular erosion, tegmen and sigmoid sinus erosion, and less sensitive for fallopian canal erosion and lateral sinus fistula.[57]

Rai T et al (2014) conducted a prospective study in 50 cases with CSOM and stated that HRCT is reliable for all the parameters like scutum and ossicular erosion, mastoid pneumatization, Korner's septum, 35 cholesteatoma extension in the middle ear and mastoid, and presence of complications such as mastoiditis, sigmoid sinus plate erosion, facial canal dehiscence, and labyrinthine fistula and intracranial complications with a P value < 0.05. It is not reliable for tegmen tympani erosion and posterior fossa dural plate erosion.[58]

Rogha M et al (2014) conducted a retrospective study in 36 patients and concluded that a preoperative CT scan can be helpful for diagnosis and planning the surgery in cases of cholesteatoma , ossicular erosion and other complications. The CT scan can correctly predict the extent of disease and is helpful for detection of lateral semicircular canal fistula, erosion of dural plate, and ossicular chain erosion. [59]

Thukral CL et al (2015), conducted a prospective study on 50 cases out of which 83.33% had cholesteatoma. He concluded that the surgical and radiological findings showed a high level of sensitivity (89.29%) in the identification of cholesteatoma. HRCT provides a good sensitivity of 80.65% in the identification of changes to the ossicular chain regardless of the presence of surrounding soft tissue. HRCT was highly informative in identification of erosion of lateral semicircular canal. However, for detecting the facial canal dehiscence, HRCT showed a low sensitivity of 33.33%. The clinical and HRCT findings showed a high level sensitivity with intraoperative findings as regards to the presence of cholesteatoma, changes of the ossicular chain and horizontal semicircular canal erosion.[42]

Sunitha M et al (2015) [60] did a study on 45 cases of chronic suppurative otitis media, 34 patients (76%) were between 20-50 years age group with mean age group was 31 years. Among the 45 patients, 36 were diseased unilaterally and 9 cases bilateral. So there were 54 diseased ears. By clinical diagnosis, tubotympanic type of CSOM was seen in 37 cases with 16 cases on the right side and 21 cases on the left side, and atticoantral type of CSOM was seen in 17 cases with 10 cases on the right side and 7 cases on the left side. HRCT temporal bone revealed pneumatised mastoid in 18(33.3%), diploeic in 2(3.7%), sclerosed mastoid in 29(53.7%) and diseased cavity in 5(9.3%) cases. In tubotympanic type, HRCT temporal bone revealed pneumatised mastoid in 15(40.5%), diploeic in 1(2.7%), and sclerosed mastoid in 21(56.8%) cases. Of the 17 cases in atticoantral type, HRCT temporal bone revealed pneumatised mastoid in 3(17.6%), diploeic in 1(5.9%), and sclerosed mastoid in 8(47.1%) cases. Cavity was seen in 5(29.4%) cases.The study concluded that air cells and the pneumatisation

pattern, low lying dura, anteriorly placed sigmoid sinus are better detected in HRCT.The extent of disease involving the mastoid air cells and mastoid antrum is well appreciated with HRCT.

Chatterjee P et al(2015), suggested that preoperative HRCT imaging in cases of cholesteatoma, ossicular chain erosion, and semicircular canal dehiscence have good correlation with intra-operative findings. However, there was weak specificity for preoperative HRCT in detecting facial canal dehiscence, dural 36 plate erosion, and sigmoid plate erosion in COM patients. The role of HRCT lies on the early detection of cholesteatoma, and thereby using a more conservative surgical procedure (endoscopic) to eradicate the disease. It was concluded that HRCT can act as a guide to detect the nature of disease and its complications, and this information can guide the surgeon in the choice of surgery to be performed and better help the patient on the level of hearing attainable after surgery.[61]

Vallabhaneni Rohit et al (2016) did a study on 50 patients diagnosed clinically with chronic suppurative otitis media (CSOM) were referred for a HRCT of temporal bone and found that .Otorrhoea (100%) is the most common symptom. Scutum was eroded in 23 cases. Incus (24 cases) is the most commonly eroded among the ossicles. Mastoiditis and mastoid abscess(20%) was the most common complication of CSOM followed by sinus plate erosion (12%), Erosion mastoid cortex (8%), Intracranial complications like abscess, dural sinus thrombosis(6%), Facial canal dehiscence (4%) , Tegmen tympani erosion (2%) , Cochlea erosion (2%) ,Tegmen Erosion (2%) Lateral semicircular canal erosion(2%) Cholesteatomas were observed in 26 cases of which 9 cases were in attic, 6 cases were Attico-antral, 4 cases were in Mesotympanum, 7 cases were holotympanic. Various HRCT findings of temporal bone in chronic suppurative otitis media with cholesteatoma were non-dependent soft tissue mass in 25 cases, Scutum erosion in 23 cases , Ossicle erosion in 20 cases , Labyrinthine fistula in 2 cases , Sigmoid sinus plate erosion in 6 cases , Mastoid cortex erosion in 4 cases , Tegmen erosion in 1 case and Mastoiditis with sub-periosteal abscess in 4 cases.[62]

Boruah DK et al (2016) conducted a retrospective study including 60 patients with clinically suspected temporal bone or ear pathologies. The imaging findings of all cases were correlated with the surgical findings. Out of 60 patients, 63.3% had unsafe CSOM with cholesteatoma. The HRCT findings with surgical correlation showed a high 91.89% sensitivity for identifying cholesteatoma. HRCT also provided good sensitivity for detecting erosion of scutum (90.32%), erosion of ossicular chain (86.96%) and erosion of lateral semi-circular canal (80%). HRCT had lower sensitivity (66.67%) for identifying facial canal dehiscence. It was concluded that the HRCT findings showed a good sensitivity with intraoperative findings in identification of cholesteatoma, erosion of scutum, ossicular chain and semi-circular canal.[63]

Tak J et al (2016) carried out study on 50 patients diagnosed with CSOM Of attico-antral type. It was found that 80% of the patients presented with chief complaint of otorrhea. It was inferred that HRCT was highly sensitive (96%) in diagnosing cholesteatoma. The HRCT had sensitivity of 100%, 97% and 88% for diagnosing the disease in epitympanum, antrum and aditus respectively. CT scan recognized erosion of malleus with 100% sensitivity and specificity and erosion of incus with sensitivity of 91% and specificity of 100%. Therefore it was concluded that HRCT was helpful in determining the detailed anatomy of the middle ear and mastoid, and in accurately predicting the extent of CSOM.[64]

Sharma VK et al (2017) conducted a study on 50 patients who were diagnosed of unsafe CSOM. It was found that ossicular chain erosion was the most common (90%)finding followed by scutum erosion (84%). Sigmoid sinus plate erosion was detected in only one case (2%). In ossicular chain erosion, incus was the most common ossicle to be eroded (92%) followed by malleus (66%). It was concluded that HRCT temporal bone delineates the location and extent of the disease and provides information on anatomical variations and complications.[65]

Happani Hiral et al (2018) did a study on 50 patients out of which 32 were males and 18 were females. Cholesteatoma was found in 29

patients, followed by ear ossicle erosion (22 patients),mastoditis (15 patients),tympanic membrane perforation (6 patients),labyrinthine fistula (3 patients) and malignancy (2 patient). Epitympanum was involved in 29 patients followed by antrum (28 patients),mastoid air cells (22 patients), aditus (19 patients), mesotympanum (12patients) ,hypotympanum (12patients), perilabyrinthine cells (5 patients). Amonst the complicated cases, brain abscess was found in 4 patients followed by mastoid abscess (2 patients),labyrinthine fistula (1patient),facial nerve palsy (1 patient) and meningitis (1 patient). [66]

Prakash MD et al (2018) conducted a prospective study involving 30 cases of CSOM with cholesteatoma. HRCT delineated ossicular erosion except stapes suprastructure erosion which had 81.8% sensitivity and specificity 88.88%. HRCT showed high sensitivity and specificity for diagnosing scutum erosion, mastoid cortex erosion, tegmen erosion, jugular bulb dehiscence and external auditory canal erosion. It showed moderate sensitivity for LSCC Erosion (75%), Facial canal erosion (80%) and Sinus plate erosion (85.7%). It was concluded that preoperative CT temporal scan of patients with CSOM serves as an important tool in surgical approach for otolaryngologists.[67]

Singh, J., & Bhardwaj, B. et al (2019). conducted a study in 60 patients to evaluate the efficacy of HRCT temporal bone in determining ossicular erosion in cases of CSOM. It was a diagnostic observational study where surgical finding of ossicular erosion was taken as a gold standard. Sensitivity specificity; positive predictive value and negative predictive value of HRCT was calculated in detecting malleus; incus and stapes erosion. P value was calculated. Sensitivity and specificity for malleus erosion was 78.5% and 78.1% respectively. Sensitivity and specificity for incus erosion was 73.1% and 57.8% respectively. Sensitivity and specificity for stapes erosion was 52% and 57.1% respectively. P value was less than 0.05. The study concluded that HRCT is a good adjunct for determining the ossicular erosion and its use should be encouraged by the otologist.[68]

V Pramod et al (2020) conducted prospective study on 30 patients who were diagnosed with CSOM .Among 30 surgical cases,

most of them were atticoantral (53.4%) followed by tubotympanic CSOM (46.6%). On surgical correlation, HRCT has a high sensitivity (84.36%), specificity (80%), PPV of 90.4% and accuracy of 90% in the diagnosis of type of CSOM. A significant association with p value<0.05 was seen for cholesteatoma, ossicle, bone, masotoiditis, scutum, tegmen and prussack space involvement. HRCT had a high sensitivity and specificity in detection of cholesteatoma (86.4%, 88.9%).[69]

Singh, Ramandeep et al (2020) conducted a prospective study on 50 patients (28 males: 22 females; mean age 24 ± 14 years) who presented with clinically suspected unsafe CSOM Out of 50 patients, left, right, and bilateral ear involvement were seen in 42% (21/50), 38% (19/50), and 20% (10/50) patients, respectively. Ear discharge was the most common symptom (100%) followed by earache (66%), vertigo (16%), and tinnitus (14%), respectively. Cholesteatoma was reported in 82% (49/60) of ears on HRCT while histopathological and intraoperative evaluation confirmed the diagnosis in 40 out of 49 ears. In 18% (11/60) ears, the cholesteatoma was not diagnosed on HRCT evaluation; however, the intraoperative and histopathological assessment revealed cholesteatoma in six patients while the rest had granulation tissue. For detection of ossicular erosions, tegmen erosions, erosions of facial nerve canal, erosions of sigmoid sinus plate, and erosions of lateral/posterior semicircular canals; HRCT had high sensitivity (86.44%–100%) and specificity (93.33%–100%).[70]

Rehman et al (2021) did a study on 55 patients . Majority of patients were in the age group of 21- 31 (56.36%) male and 24(43.64%) female patients. The study showed 48(87.27%) patients on HRCT that included erosion of scutum, tegmen, sigmoid Sinus plate, external auditory canal, Facial nerve canal, lateral semicircular canal and erosion of Malleus, Incus and stapes in 37(67.27%) patients,7(12.72%) pa 7(12.72%) patients, 5(9.09%) patients,3(5.45%) patients,20(36.36%) patients, 31(56.36%) patients and 24(43.63%) patients and the results for the same findings intra were 36 (65.45%) patients, 8(14.54%) patients,5(9.09 7(12.72%) patients,2(3.63%) patients, 24(43.63%) patients, 34(61.81%) patients and 26(47.27%)

patients respectively. In the detection of bony erosion HRCT showed an average sensitivity of 85.96%, specificity of 99.91%,PPV of an average accuracy of 96.52% and results for the detection of soft tissue lesions depicting cholesteatoma showed an average sensitivity of 98.20%,specificity of 96.88%,PPV of 89.42%,NPV of 96.75% and an average accuracy of 97.7 % [71]

MATERIALS AND METHODS

The present study was conducted in the Department of Radiodiagnosis and ENT for a period of 1.5 year from Dec 2019 to May 2021, in which all patients referred to the department of Radiodiagnosis for HRCT temporal bone with suspicion or diagnosis of chronic suppurative otitis media (CSOM) were included.

A thorough clinical history was taken from each patient regarding various symptoms like ear discharge, earache, hearing loss, fever etc.

Clinical examination of ear, nose, and throat / otoscopic findings, tuning fork tests, pure tone audiometry and laboratory investigation were done by otorhinolaryngologist. Informed consent was taken from each patient.

Then an HRCT scan of the temporal bone was done in all cases on 128 slice Seimens CT scanner. Findings were recorded and tabulated according to the proforma.

Imaging findings were then compared and correlated with the clinical /intra-operative findings (wherever possible) to calculate the sensitivity, specificity, positive and negative predictive value of HRCT temporal bone by using various statistical tests.

7.1 Source of Data

The study was conducted on patients who were clinically suspected or diagnosed with chronic suppurative otitis media in Department of ENT, DMCH Ludhiana and were referred to Department of Radiodiagnosis for HRCT temporal bone .

7.2 METHOD OF COLLECTION OF DATA

The patients diagnosed with chronic suppurative otitis media in Dayanand Medical College and Hospital, Ludhiana were the participants in the study. The data was collected by personal interviews / Case Registration file / Investigations done on routine basis and the investigation results . Details of past medical history, age, was also taken into consideration. Then an HRCT Temporal bone scan was done .Findings were recorded & tabulated and were compared and correlated with the clinical / operative findings (wherever possible).

Inclusion criteria: Patients diagnosed or clinically suspected with chronic suppurative otitis media . **50 clinically diagnosed patients were the subjects for study . Out of which only 15 had undergone surgery .**

Exclusion criteria:

1. History of ear trauma.
2. Patients with suspicion of malignancy on imaging .
3. History of previous ear surgery .
4. Pregnant women .
5. Patients who refuse to participate in the study .

Duration of study: 1.5 year Prospective

Outcome: The study revealed the role and accuracy of HRCT temporal bone to know the extent &severity of disease in cases of chronic suppurative otitis media.

Statistical analysis: Data was described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate. For comparing categorical data, Chi square ($\chi 2$) test were performed and exact test were used when the expected frequency is less than 5.Senstivity, specificity ,positive predictive value (PPV) and negative predictive value (NPV) was calculated of HRCT temporal bone as compared to peroperative findings . A probability value (p value) less than 0.05 was considered statistically significant. All statistical calculations were done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows

OBSERVATIONS AND RESULTS

The present study was carried out with an aim to evaluate the role of High Resolution Computed Tomography Temporal Bone in Chronic Suppurative Otitis Media. The study was conducted in the Department of Radiodiagnosis, Dayanand Medical college and hospital, Ludhiana in close association with Department of ENT from Nov 2019 to May 2021. In our descriptive study,50 (n1=50) patients with clinical diagnosis of CSOM who were referred from Department of ENT for HRCT temporal bone. Out of 50 patients 14 had bilateral disease and 36 had unilateral disease so the total number of diseased ears became 64 (n2= 64).Out of 50 patients ,only 15(n3= 15) patients underwent surgery and others were under medical management. So three sets of results were inferred with 3 n's [number of cases] .

DEMOGRAPHIC DATA (n1 = 50)

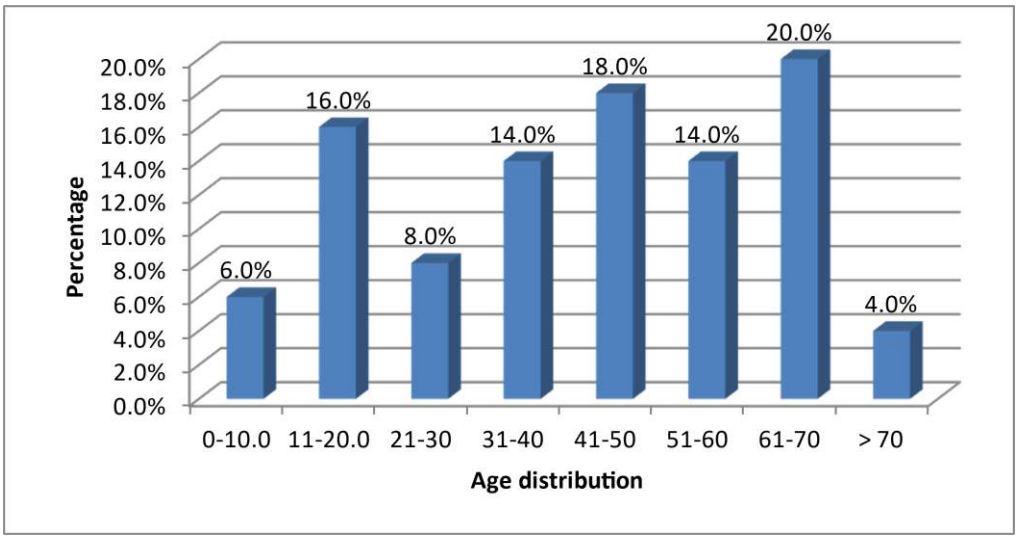
1) Distribution according to age of the patients (n1 = 50).

The study was conducted on 50 patients with clinical diagnosis of CSOM. The age of patients ranged from 05 years to 78 years. Maximum number of patients were in the age group after 7^{th} decade of life (20.0 %). The mean age was 41.6 yrs.

Table 1. Distribution of cases according to age (n1=50)

Age group	No. of cases(n1=50)	Percentage
0-10.0	3	6.0%
11-20.0	8	16.0%
21-30	4	8.0%
31-40	7	14.0%
41-50	9	18.0%
51-60	7	14.0%
61-70	10	20.0%
> 70	2	4.0%
Total	50	100%

Figure 11 .Distribution of cases according to age (n1=50)



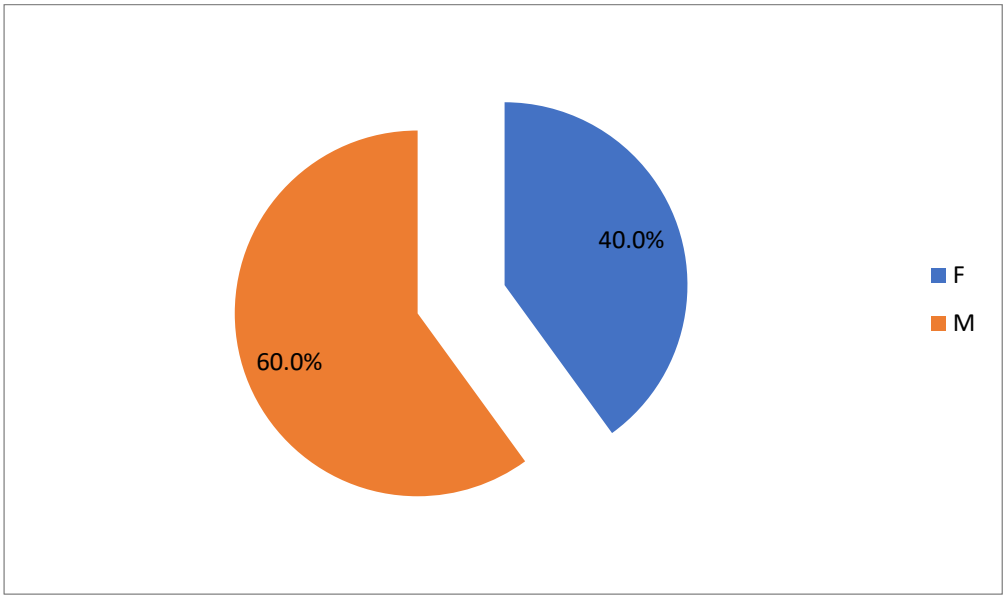
2) Distribution of cases according to gender (n1= 50)

Out of 50 patients, the majority of the cases were males (60%) and 20(40%) were females .The male to female ratio of study population was 3:2.

Table 2 .Distribution of cases according to gender (n1=50)

SEX	NO. OF CASES(n1=50)	PERCENTAGE
Female	20	40.0%
Male	30	60.0%
Total	50	100.0%

Figure 12. Distribution of cases according to gender(n1=50)



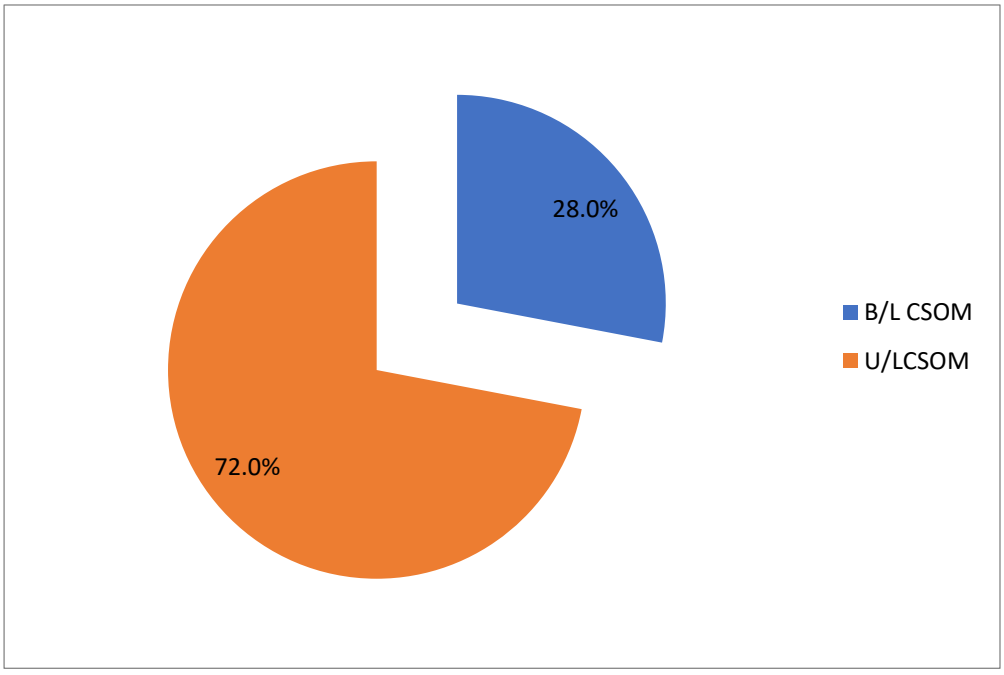
3) Distribution of cases whether the disease is unilateral or bilateral . (n1=50)

Out of 50 patients ,36 (72%) had unilateral disease and 14 (28%) had bilateral disease.

Table 3. Distribution of cases whether the disease is unilateral or bilateral . (n1=50)

	NO. OF CASES (n1=50)	PERCENTAGE
BILATERAL	14	28.0%
UNILATERAL	36	72.0%
Total	50	100.0%

Figure 13 Distribution of cases whether the disease is unilateral or bilateral.(n1=50)



According to second set of patients i.e total number of ears involved was 64 so total number of cases turned out to be 64 .

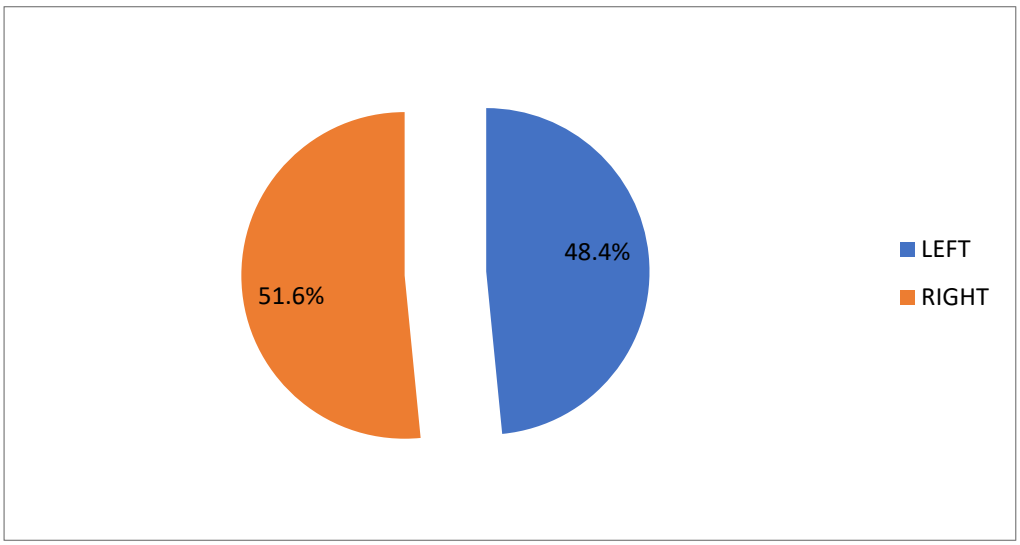
4) Distribution of cases according to side affected (n2=64)

Out of 64 patients, 33 patients had right ear involvement and 31 had left ear involvement.

Table 4. Distribution of cases according to side affected (n2=64)

SIDE AFFECTED	NO. OF CASES (n2=64)	PERCENTAGE
RIGHT	33	51.6 %
LEFT	31	48.4 %
Total	64	100.0%

Figure 14. Distribution of cases according to side affected (n2=64)



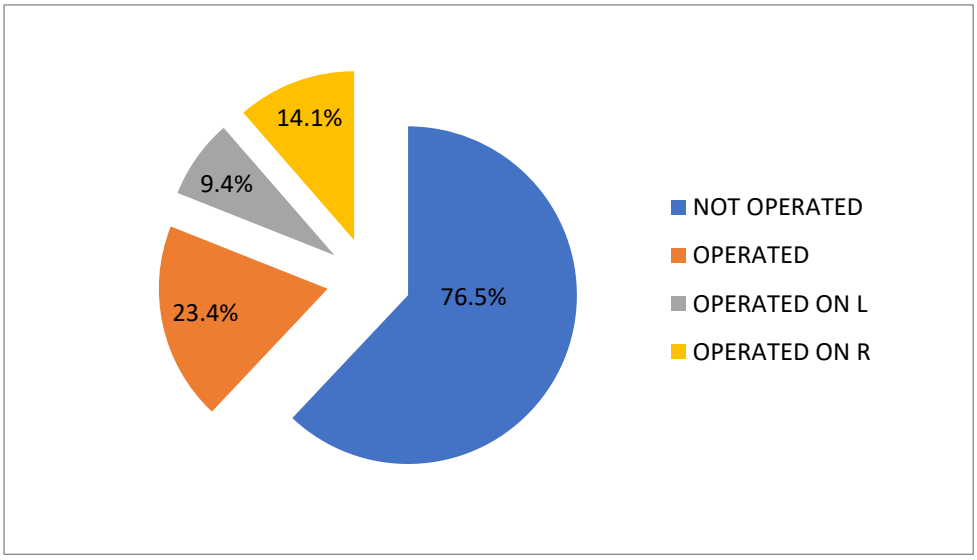
5) Distribution of patient according to operative status (n2= 64).

Out of 64 patients, only 15(23.4 %) underwent surgery and 49(76.6%) did not . Out of operated 15 patients, 6(9.4%) patients were operated on left side and 9 (14.1%)on right side .

Table 5. Distribution of cases according to operative status (n2= 64).

OPERATIVE STATUS	NO. OF CASES (n2=64)	PERCENTAGE
NOT OPERATED	49	76.5%
OPERATED ON LEFT	6	9.4%
OPERATED ON RIGHT	9	14.1%

Figure 15.Distribution of cases according to operative status (n2= 64).



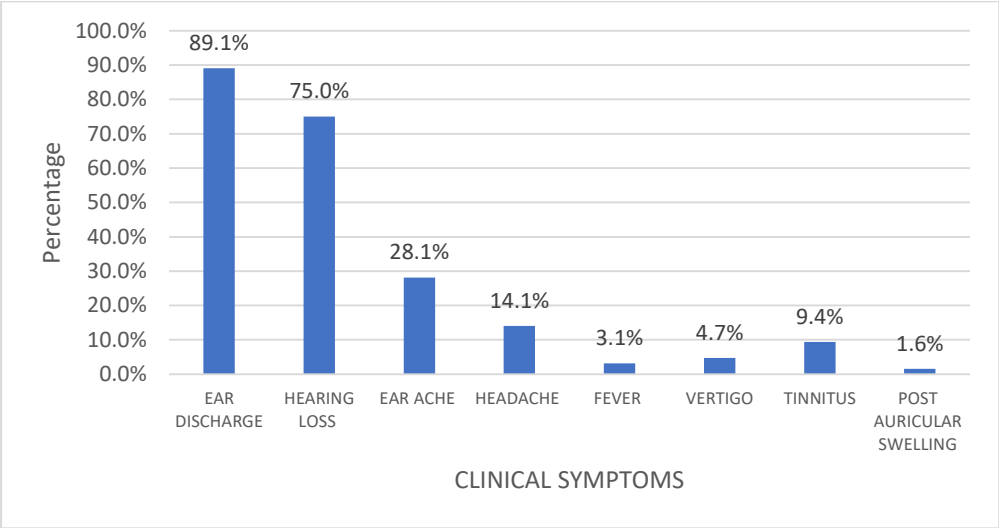
6. Distribution of cases according to symptoms of the patients (n2 =64)

The chief presenting symptoms were ear discharge seen in 57 (89.1%) cases , decreased hearing in 48 (75%,) cases, earache in 18 (28.1%) cases, headache in 9 (14.1 %) cases,fever in 2 (3.1 %) cases, tinnitus in 6 (9.4%) cases, vertigo in 3 (4.7%) cases and post auricular swelling in 1 (1.6 %) cases. Ear discharge was the most common presenting complaint followed by hearing loss.

Table 6. Distribution of cases according to symptoms of the patients (n2 =64)

CLINICAL SYMPTOMS	CASES (n2=64)	
	NO. OF CASES	PERCENTAGE
EAR DISCHARGE	57	89.1%
HEARING LOSS	48	75.0%
EAR ACHE	18	28.1%
HEADACHE	9	14.1%
FEVER	2	3.1%
VERTIGO	3	4.7%
TINNITUS	6	9.4%
POST AURICULAR SWELLING	1	1.6%

Figure 16. Distribution of cases according to symptoms of the patients (n2 =64)



DISTRIBUTION OF CASES ACCORDING TO HRCT FINDINGS.

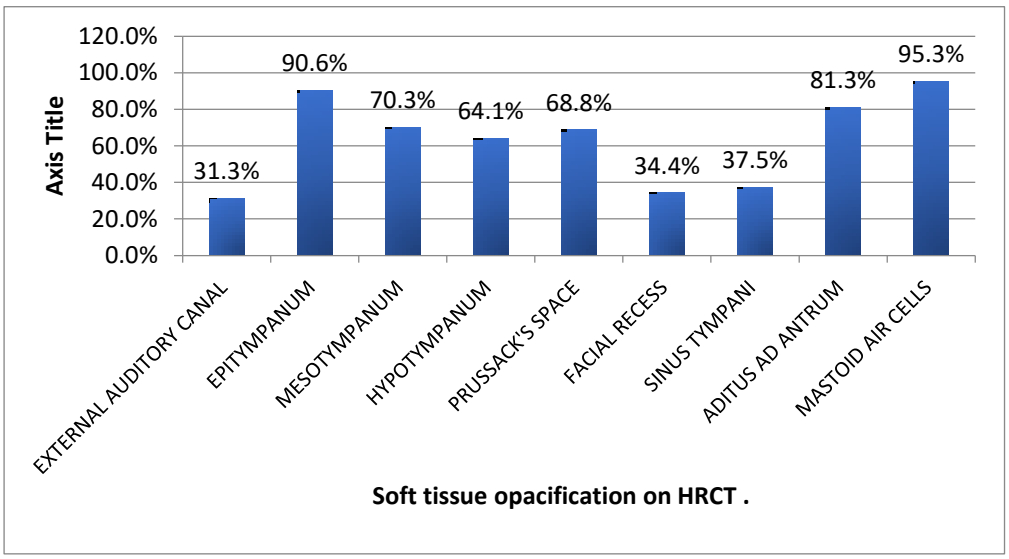
7. Distribution of the cases according to HRCT finding of soft tissue opacification (n2=64)

The most common site of involvement i.e soft tissue opacification in middle ear cavity was epitympanum seen in 58(90.6%) cases followed by mesotympanum in 45(70.3%) cases , in hypotympanum 41 (64.1%) cases . The involvement of recesses was facial recess seen in 22 (34.4 %) cases, sinus tympani in 24 (37.5 %) cases and prussack's space was seen in 44 (68.8%) cases .In the mastoid part , aditus ad antrum was involved in 52 (81.3 %) cases and mastoid air cells were involved in 61 (95.3 %) cases. The soft opacification in external auditory canal was seen in 20 (31.3 %) cases.

Table 7. Distribution of the cases according to HRCT finding of soft tissue opacification (n2=64)

HRCT FINDINGS	CASES (n2=64)	
SOFT TISSUE OPACIFICATION	**NO. OF CASES**	**PERCENTAGE**
EXTERNAL AUDITORY CANAL	20	31.3%
EPITYMPANUM	58	90.6%
MESOTYMPANUM	45	70.3%
HYPOTYMPANUM	41	64.1%
PRUSSACK'S SPACE	44	68.8%
FACIAL RECESS	22	34.4%
SINUS TYMPANI	24	37.5%
ADITUS AD ANTRUM	52	81.3%
MASTOID AIR CELLS	61	95.3%

Figure 17. Distribution of the cases according to HRCT finding of soft tissue opacification (n2=64)



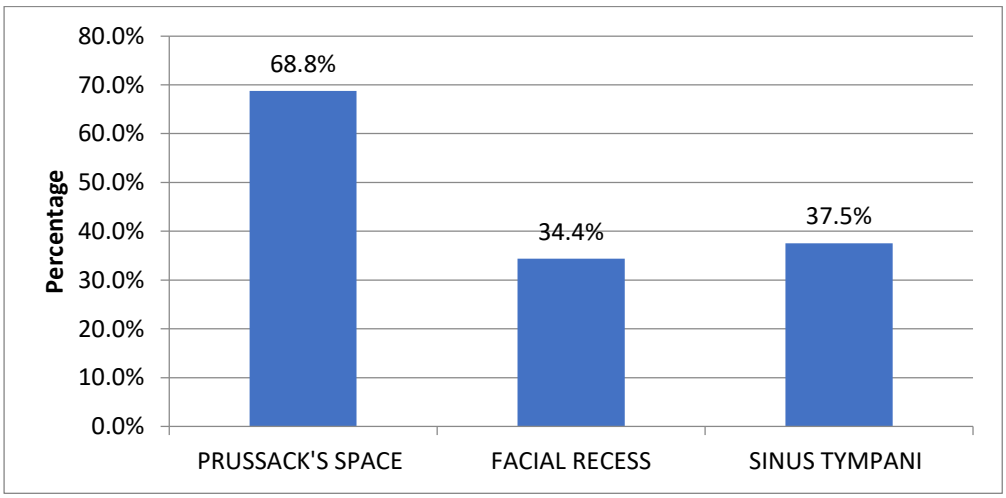
8. Distribution of cases according to soft tissue opacification of the recesses on HRCT (n2=64)

The soft tissue density in Prussack's space was seen in all 44 (68.8%) cases. Involvement of retrotympanum by the disease i.e. facial recess and sinus tympani was seen in 22 and 24 (34.4% and 37.5%) cases respectively.

Table 8 Distribution of cases according to soft tissue opacification of the recesses on HRCT (n2=64)

HRCT FINDING	CASES (n2=64)	
SOFT TISSUE OPACIFICATION OF RECESSES	NO. OF CASES	PERCENTAGE
PRUSSACK'S SPACE	44	68.8%
FACIAL RECESS	22	34.4%
SINUS TYMPANI	24	37.5%

Figure. 18 Distribution of cases according to soft tissue opacification of the recesses on HRCT (n2=64)



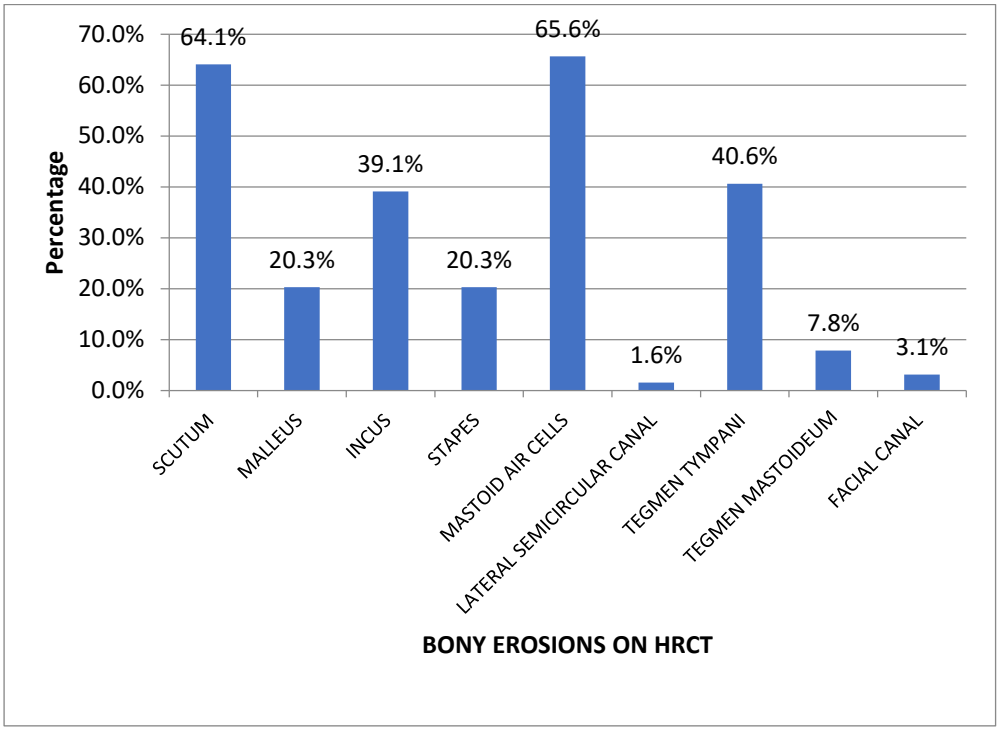
9. Distribution of the cases according to bony erosions on HRCT (n2=64)

The most common site of bony erosions in middle ear was scutum seen in 41 (64.1%) cases followed by tegmen tympani in 26 (40.6%) cases , incus in 25 (39.1%) cases , malleus in 13 (20.3%) cases, ,stapes in 13 (13%) cases , facial canal in 2 (3.1 %) cases and lateral semicircular canal in 1 (1.6%) case .In the mastoid part , mastoid air cells in 42 (65.1%) cases and tegmen mastoideum in 5 (7.8%) cases .

Table 9 Distribution of the cases according to bony erosions on HRCT (n2=64)

EROSIONS ON HRCT	CASES (n2=64)	
	NO. OF CASES	PERCENTAGE
SCUTUM	41	64.1%
MALLEUS	13	20.3%
INCUS	25	39.1%
STAPES	13	20.3%
MASTOID AIR CELLS	42	65.6%
LATERAL SEMICIRCULAR CANAL	1	1.6%
TEGMEN TYMPANI	26	40.6%
TEGMEN MASTOIDEUM	5	7.8%
FACIAL CANAL	2	3.1%

Figure 19. Distribution of the cases according to bony erosions on HRCT (n2=64)



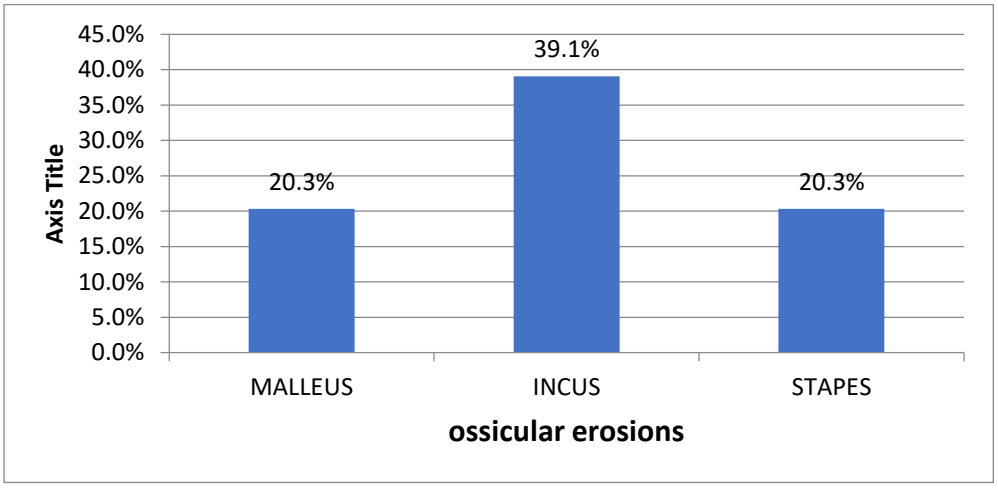
10.Distribution of the cases according to ossicular erosions on HRCT (n2=64)

The most common ossicular erosion was of incus seen in 25 (39.1%) cases followed by incus and stapes 13 (20.3%) cases each .

Table 10. Distribution of the cases according to ossicular erosions on HRCT (n2=64)

OSSICULAR EROSIONS ON HRCT	CASES (n2=64)	
	NO. OF CASES	PERCENTAGE
MALLEUS	13	20.3%
INCUS	25	39.1%
STAPES	13	20.3%

Figure 20. Distribution of the cases according to ossicular erosions on HRCT (n2=64)



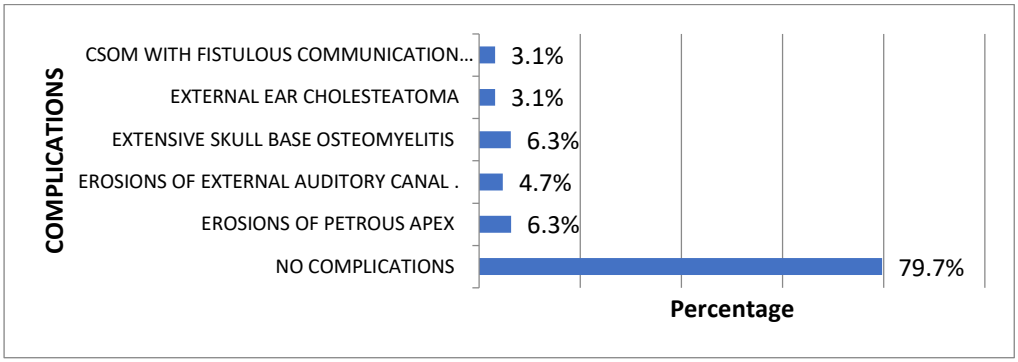
11**.Distribution of cases according to complications of chronic suppurative otitis media on HRCT (n2=64)**

The complications seen in patients with CSOM were erosion of bony external auditory canal 3 (4.7%) cases, erosion of petrous apex seen in 4 (6.3 %) cases, skull base osteomyelitis seen in 4 (6.3%) cases and external ear cholesteatoma was seen in 2 (3.1%) cases .1 patient had developed fistulous communication between external auditory canal and mastoid antrum. Out of 64 cases, 51(79.7%) did not develop any complications .

Table 11. Distribution of cases according to complications of chronic suppurative otitis media on HRCT (n2=64)

COMPLICATIONS ON HRCT	**CASES (n2=64)**	
	NO. OF CASES	**PERCENTAGE**
NO COMPLICATIONS	51	79.7%
EROSIONS OF PETROUS APEX	4	6.3%
EROSIONS OF EXTERNAL AUDITORY CANAL .	3	4.7%
EXTENSIVE SKULL BASE OSTEOMYELITIS	4	6.3%
EXTERNAL EAR CHOLESTEATOMA	2	3.1%
CSOM WITH FISTULOUS COMMUNICATION BETWEEN EAC AND MASTOID ANTRUM	2	3.1%
TOTAL	64	100%

Figure 21. Distribution of cases according to complications of chronic suppurative otitis media (n2=64)



12. Correlation between HRCT findings and intraoperative findings (n3=15).

Out of 50 patients, only 15 underwent surgery, so for correlation purpose n3= 15. Out of 15 patients, HRCT was able to diagnose soft tissue opacification in epitympanum, mesotympanum and hypotympanum with sensitivity of 90%, 92.1% and 100% respectively and specificity of 66.6%, 100% and 50 % respectively. Its sensitivity and specificity to detect involvement of recesses respectively was i.e prussack's space was 100% and 50 %, sinus tympani was 100% and 66.7% and facial recess was 60% and 60%. Its sensitivity and specificity to detect bony erosions of scutum was 100 %and 62.5%, malleus was 66.6 %and 88.8 % , incus was 77.7 % and 66.6 %, stapes was 50 % and 85.7 %, mastoid air cells was 100 % and 100% , tegmen tympani was 100 % and 90.9 % and tegmen mastoideum 100 % and 100 % respectively.

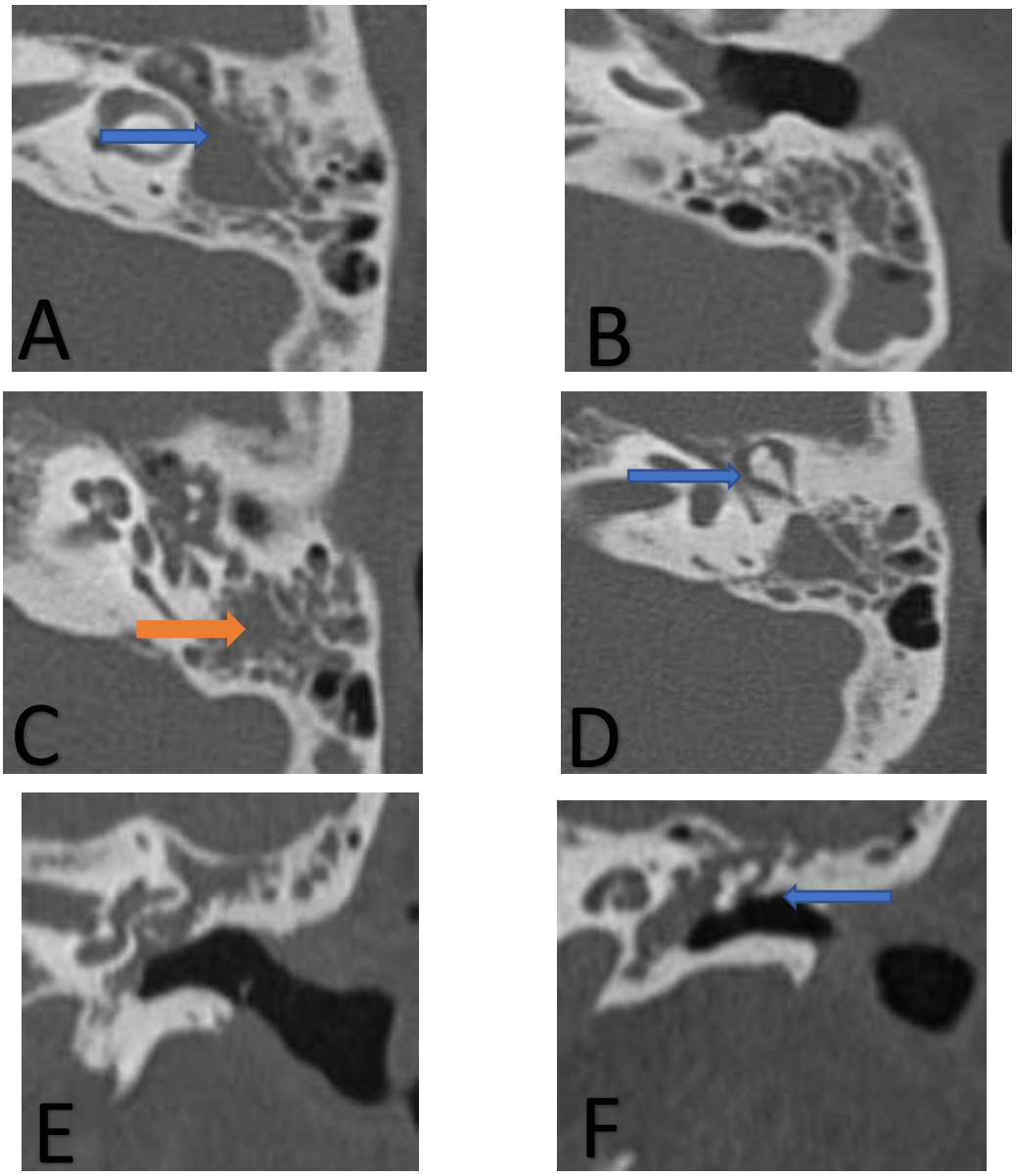
Table 12. Correlation between HRCT and operative findings(n3=15)

Findings (n3=15)	HRCT	Intra operative	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy	p-value
STO IN EAC	**3**	3	100	100	100	100	100%	1.000
STO in EPITYMPANUM	**12**	12	90	66.6	90	66.7	84.40%	0.024
STO in MESOTYMPANUM	**12**	13	92.1	100	100	66.6	93.30%	0.018
STO in HYPOTYMPANUM	**10**	11	100	50	75	100	80%	0.074
ST in PRUSSACK'S SPACE	**12**	9	100	50	75	100	80%	0.074
STO in FACIAL RECESS	**7**	5	60	60	42.8	75	60%	0.921
STO in SINUS TYMPANI	**6**	6	100	66.7	50	66.7	60%	0.802
STO in ADITUS AD ANTRUM	**14**	14	100	100	100	100	100%	1.000
STO in OPACIFICATION OF MASTOID	**15**	15	100	100	100	100	100%	1.000
EROSIONS OF SCUTUM	**10**	7	100	62.5	70	80	80%	0.038

Findings (n3=15)	HRCT	Intra operative	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy	p-value
EROSIONS OF MALLEUS	**5**	6	66.6	88.8	80	80	80%	0.025
EROSIONS OF INCUS	**9**	9	77.7	66.6	77.7	66.6	73%	0.085
EROSIONS OF STAPES	**5**	8	50	85.7	80	60	66.60%	0.143
EROSIONS OF MASTOID AIR CELLS	**11**	11	100	100	100	100	100%	1.000
EROSIONS OF LSCC	**0**	0	100	-	-	100	-	1.000
EROSIONS OF TEGMEN TYMPANI	**5**	4	100	90.9	80	100	93.30%	0.004
EROSIONS OF TEGMEN MASTOIDEUM	**1**	1	100	100	100	100	100%	1.000
EROSION OF FACIAL CANAL	**0**	0	-	100	-	100	-	1.000

Case1. Chronic suppurative otomastoiditis without osscicular erosions.

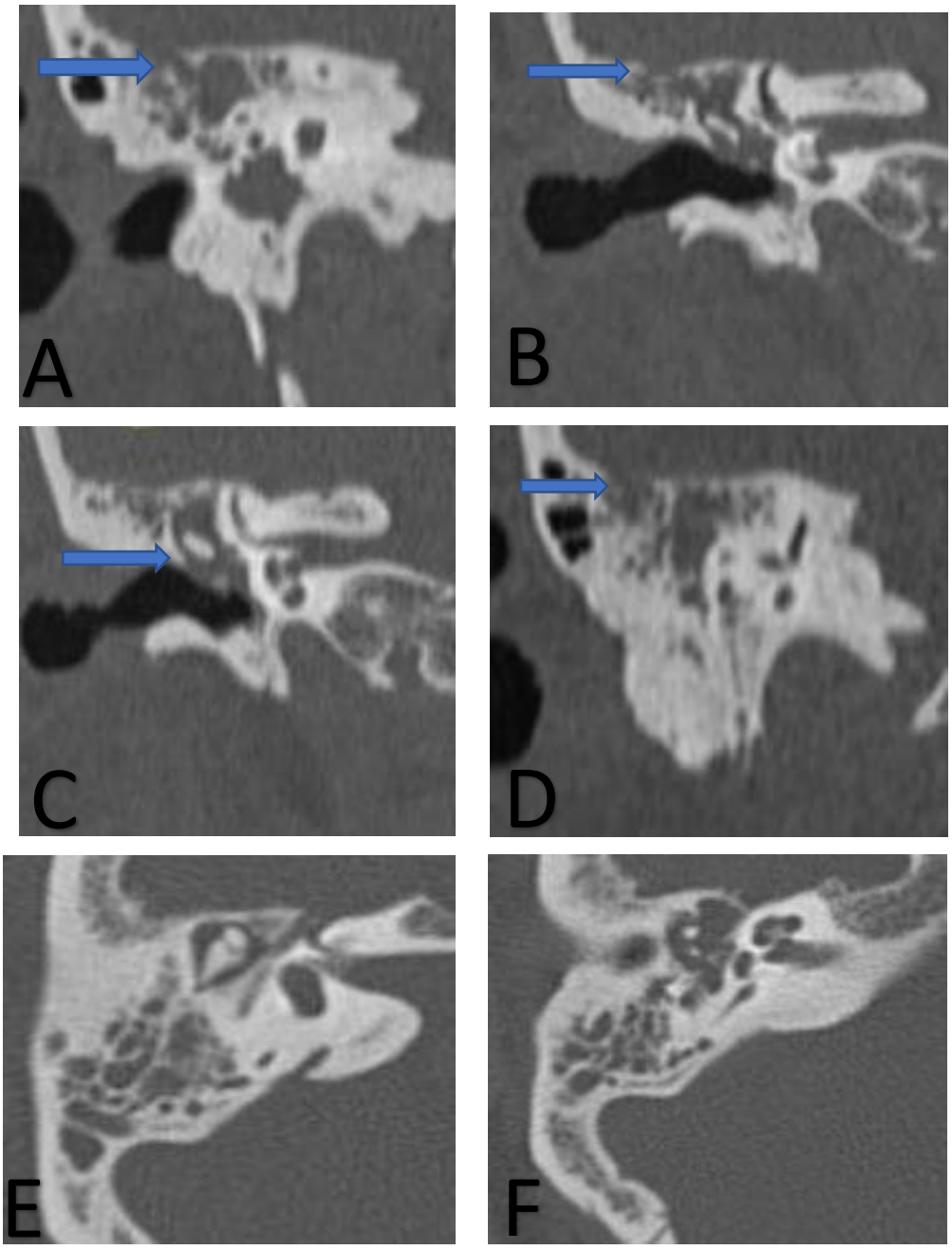
Picture 1



40 yr old patient with left sided ear discharge and hearing loss from last 1year. HRCT axial sections (A,B,C& D) of temporal bone show soft tissue opacification in right middle ear cleft with involvement of epitympanum, mesotympanum, hypotympanum and extension into mastoid antrum via aditus (arrow in A). There is associated rarefaction of mastoid septa (orange arrow in C) and ossicular erosion (orange arrow in C). HRCT coronal section (E&F) shows blunting of scutum and soft tissue density in prussack's space .Ear ossicles appears grossly unremarkable (C&D)

Case2 Cholesteatoma with bony erosions of tegmen tympani and tegmen mastoideum without ossicular erosions.

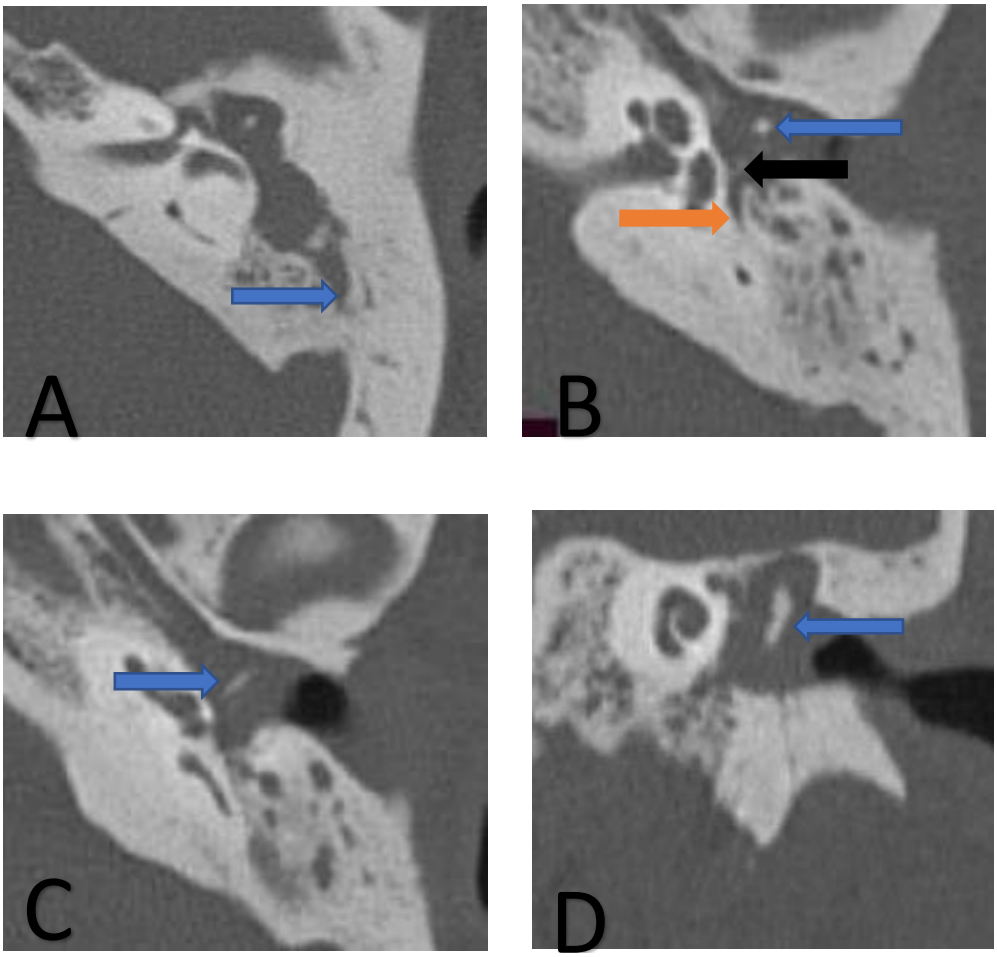
Picture 2



40 yr old patient with right sided ear discharge , ear ache and hearing loss from last 1.5 year HRCT coronal sections (A,B,C& D) of temporal bone show soft tissue density in right middle ear cleft involving epitympanum, mesotympanum, hypotympanum with extension into mastoid antrum .There is associated blunting of scutum and soft tissue density in prussack's space (arrow in C) .There are bony erosions seen involving tegmen tympani and tegmen mastoideum (arrow in A , B & D). HRCT axial section (E&F) reveals unremarkable ear ossicles.

Case3. Chronic suppurative otitis media with coalescent mastoiditis and osscicular erosions.

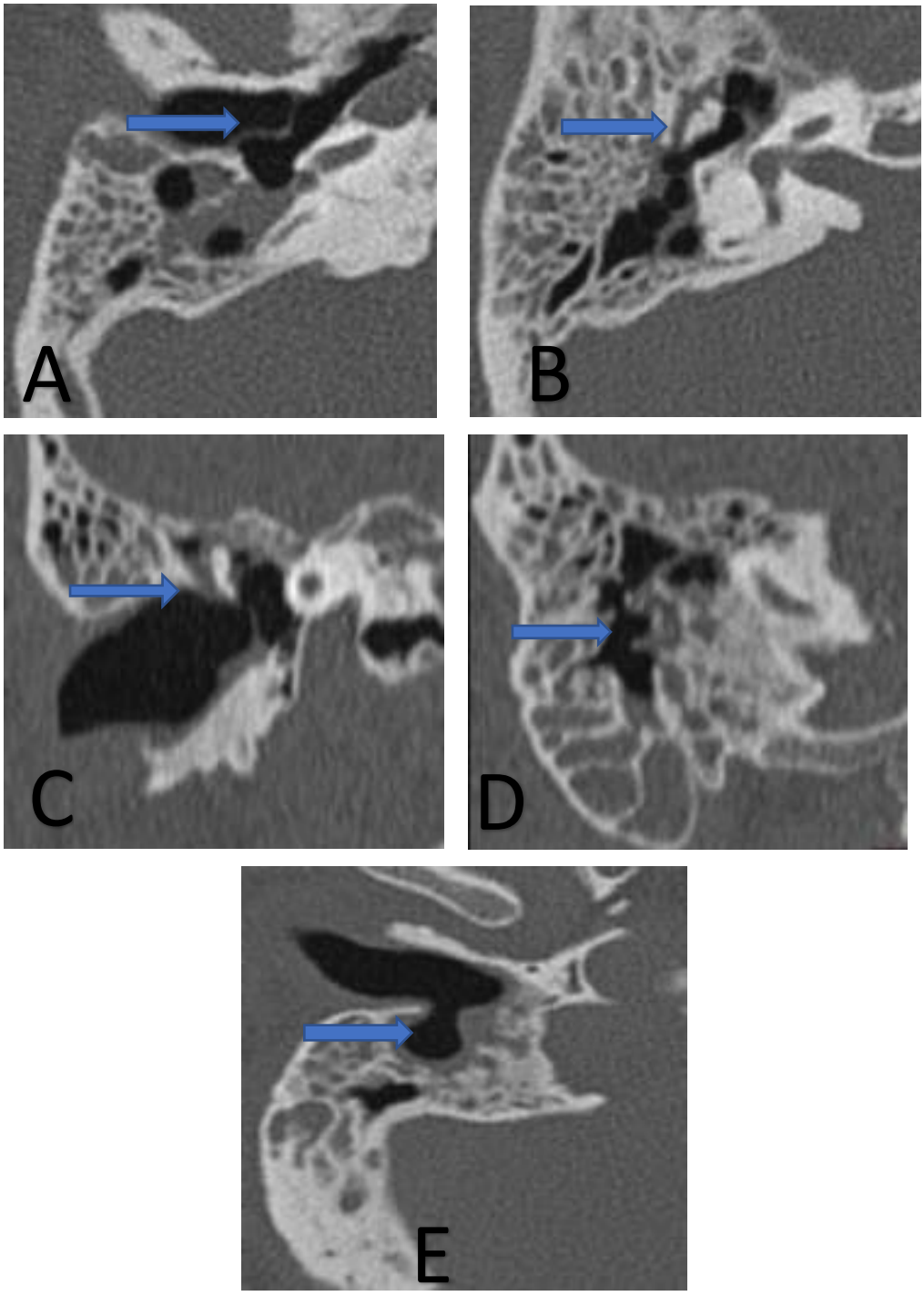
Picture 3



20 yr old patient with left sided ear discharge and hearing loss from last 2 years.

HRCT axial sections (A,B& C) , coronal section(D) of temporal bone shows complete soft tissue opacification in right middle ear cavity (involving epitympanum, mesotympanum, hypotympanum) ,mastoid air cells , sinus tympani and facial recess (orange arrow in B) . There is associated erosions of ossicles i.e malleus and incus (blue arrow in B,C & D) with relative sparing of stapes (black arrow in C) . There is sclerosis of mastoid air cells (arrow in A).

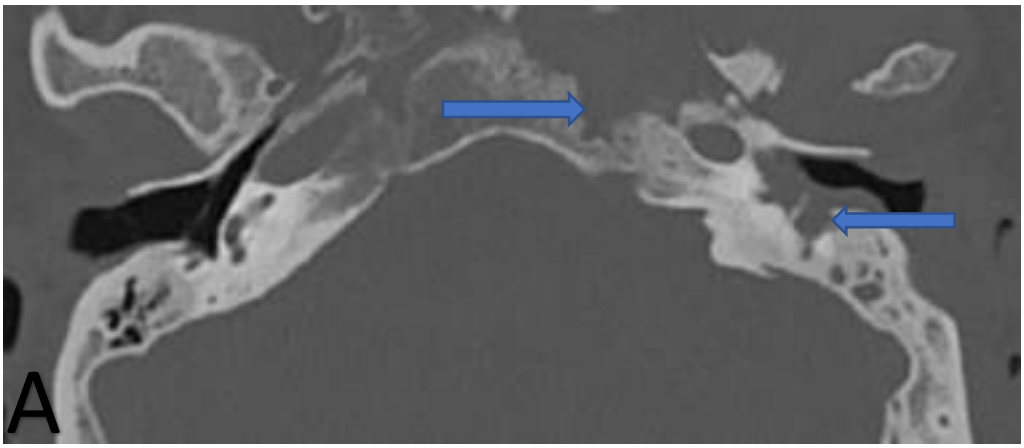
Case4 . CSOM with osscicular erosions and fistulous communication between mastoid and external auditory canal (automastoidectomy).
Picture 4

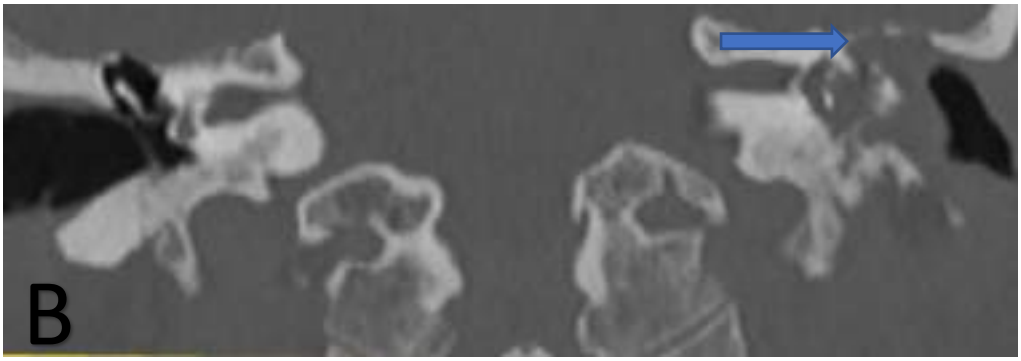


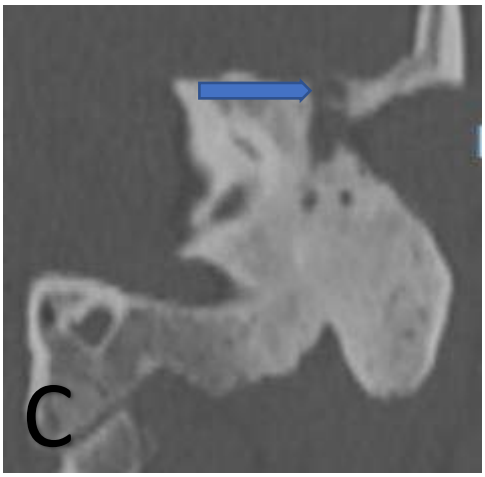
A 53 year old patient with right sided ear discharge and hearing loss from 6-7 years. HRCT axial sections (A,B& E), coronal section (C & D) of temporal bone shows retracted tympanic membrane (arrow in A), soft tissue density in epitympanum with erosions of incus (arrow in B), blunting of scutum with soft tissue density in prussack's space (arrow in C), erosion of mastoid air cells (arrow in D), fistulous communication between mastoid and external auditory canal (arrow in E) suggestive of automastoidectomy.

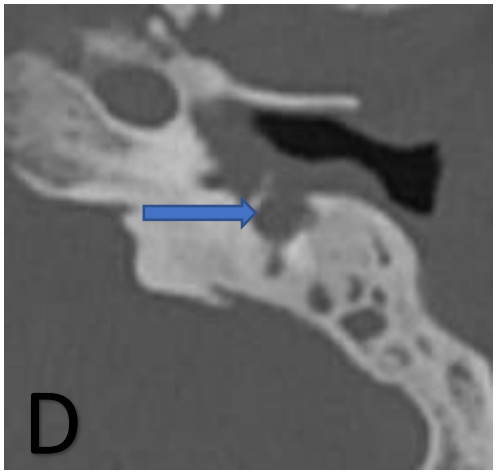
Case 5 Cholesteatoma with extensive bony erosions and skull base osteomyelitis and left side facial palsy.

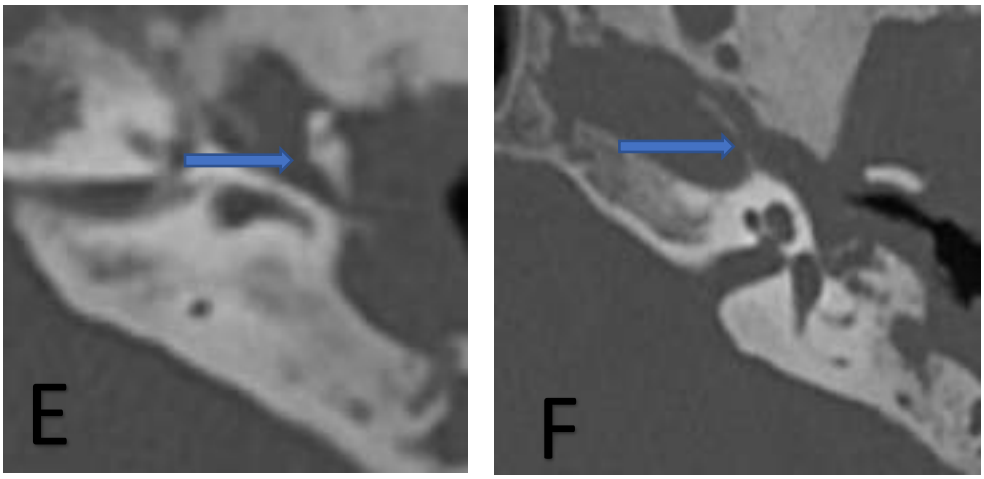
Picture 5









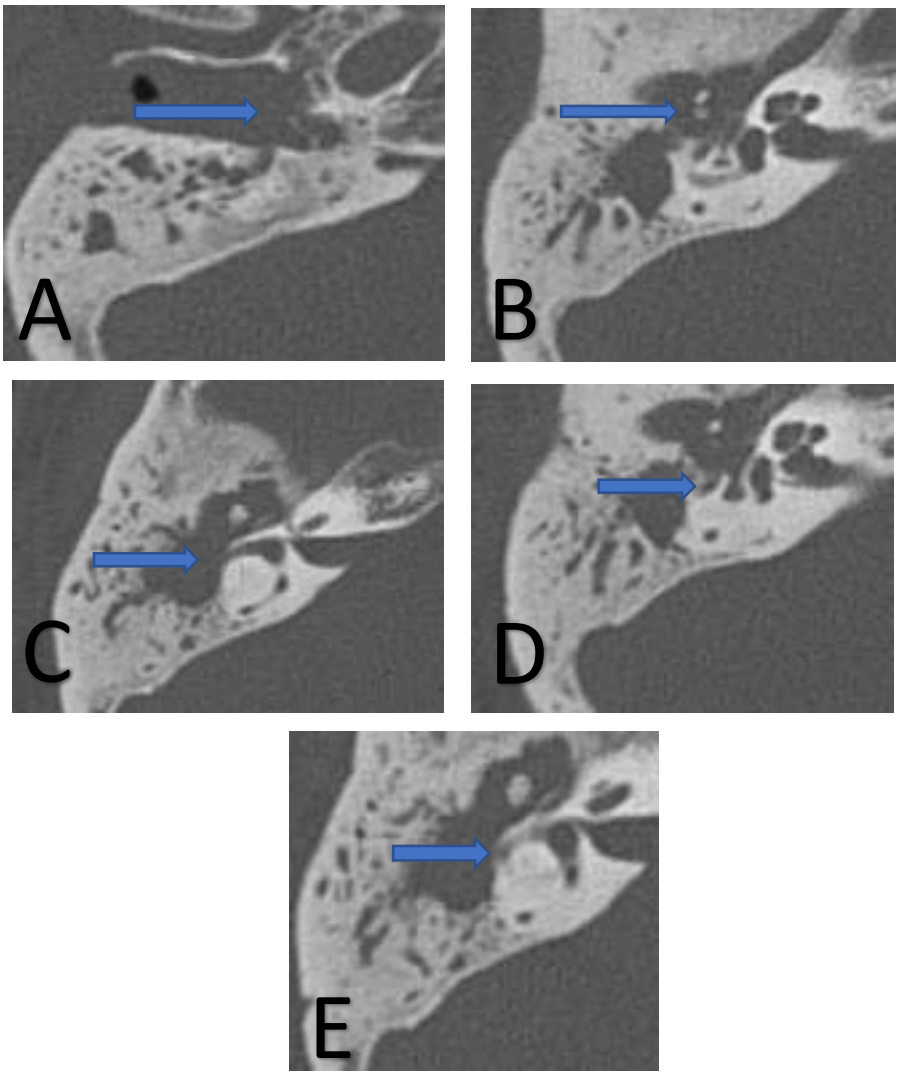


A 65 year old patient complaining of left sided ear discharge (on & off), hearing loss ,tinnitus and left sided facial palsy .

HRCT axial sections (A,D,E&F) , coronal section(B & C) of temporal bone shows complete soft tissue opacification of epitympanum , mesotympanum , hypotympanum and mastoid air cells . Extensive bony erosions seen involving petrous apex , clivus and bony external auditory canal (arrow in A) , erosions of tegmen tympani and mastoideum (arrow in B & C) , erosion of mastoid part of facial canal(arrow in D) , erosion of carotid canal (arrow in F) .Ear ossicles appear grossly unremarkable (arrow in E)

Case 6 Chronic suppurative otomastoiditis with bony erosions and dehiscence of lateral semicircular canal.

Picture 6

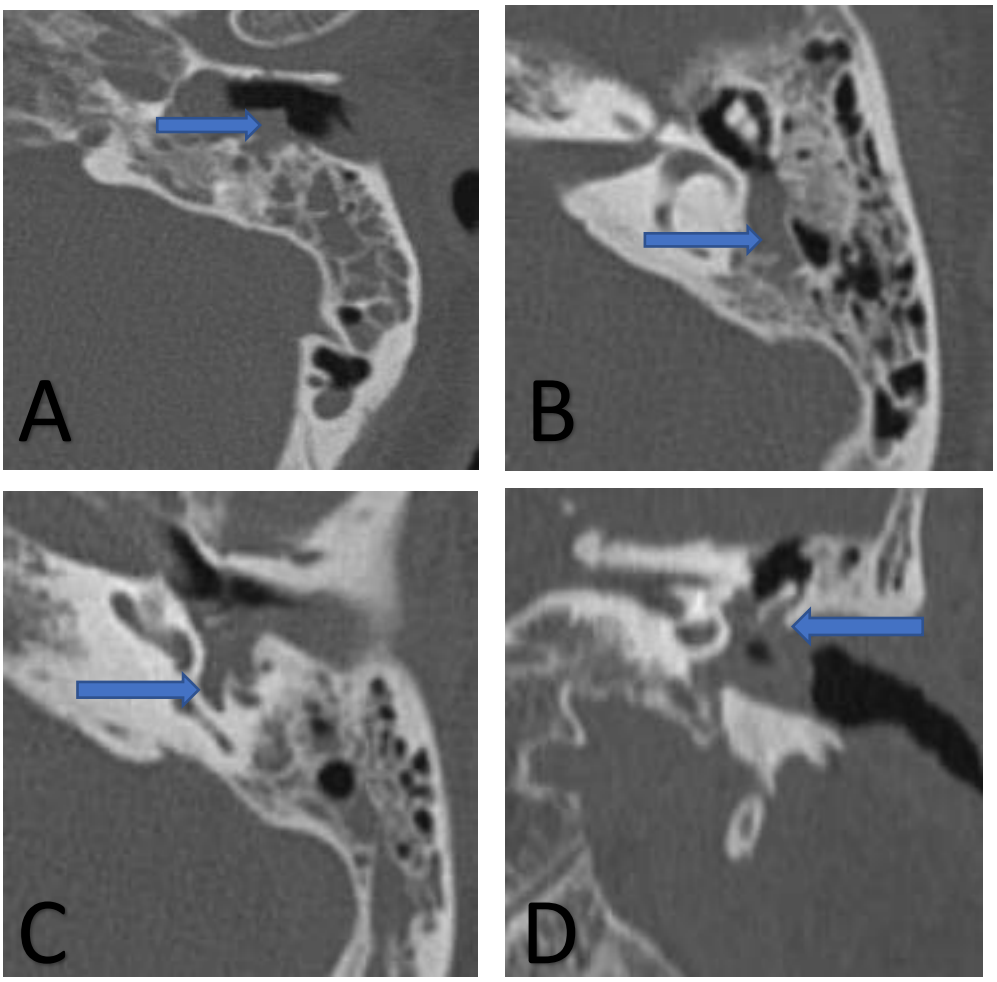


A 38 year old patient presented with right sided ear discharge , hearing loss , tinnitus and vertigo .

HRCT axial sections (A,B,C,D,&E) of temporal bone. Tympanic membrane is not separately visualised, hypodense soft tissue is seen in external auditory canal (arrow in A). There is complete soft tissue opacification of epitympanum , mesotympanum , hypotympanum ,aditus ad antrum , mastoid air cells, sinus tympani and facial recess(arrow in C & D) .Extensive bony erosions of ear ossicles are seen i.e malleus and incus , only part of suprastructure of stapes is visualized (arrow in B), erosions of mastoid air cells .There is dehiscence of lateral semicircular canal (arrow in E).

Case 7 Chronic suppurative otitis media with bony erosions and external ear cholesteatoma

Picture 7



A 70yr old patient with left sided ear discharge (on & off) and headache.

HRCT axial sections (A,B,& C) , coronal section(D) of temporal bone. Tympanic membrane is not separately visualised . Hypodense soft tissue is seen in external auditory canal with erosions of proximal part of external auditory canal (arrow in A) . Soft tissue is also seen in middle ear cleft involving epitympanum , mesotympanum , hypotympanum , aditus ad antrum ,mastoid air cells and recesses (prussack's space , sinus tympani & facial recess)(arrow in B,C & D) .There is blunting of scutum (arrow in D), ossicles appear unremarkable

DISCUSSION

The current study entitled "ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA" was a descriptive observational study conducted in Department of Radiodiagnosis, Dayanand Medical college and hospital,Ludhiana in association with Department of ENT, Dayanand Medical college and hospital, Ludhiana from Nov 2019 to May 2021.

The aim and objective of our study was to evaluate the role of HRCT as a modality in evaluation of chronic suppurative otitis media and its complications, so as to guide the otolaryngologist in appropriate treatment planning of the patient.

The chronic otitis media is defined as an inflammatory process, infectious or not, focal or generalized in the middle ear. It is can be either tubotympanic (safe) or attrico-antral (unsafe) in location.

CSOM is classified into two main clinical types: CSOM without cholesteatoma that is recognized clinically as safe type and CSOM with cholesteatoma, or unsafe type [6].

In the non-cholesteatomatous CSOM there are irreversible alterations in the middle ear epithelium that manifest as chronic otorrhea and perforation of the tympanic membrane, which requires surgical treatment for the disease control. The cholesteatomatous CSOM is defined as the presence of keratinized stratified squamous epithelium in any region of the middle ear which may be acquired or more seldom congenital. Unsafe CSOM, especially those associated with cholesteatoma, require surgical treatment. The cholesteatoma have characteristics of growth, migration and osseous erosion and are thus locally destructive. The only treatment is their full surgical removal, since there is no effective medical treatment for eradication of the disease so far.[7-9]

50 patients with clinical diagnosis of CSOM referred from Department of ENT for HRCT temporal bone were included in the study. We

evaluated HRCT features of CSOM which included a soft tissue density associated with:

- Opacification of external ear(external auditory canal), middle ear, aditus ad antrum and mastoid antrum with bony destruction.
- Opacification of prussack's space, sinus tympani and facial recess.
- Erosions of the ossicles(malleus , incus and stapes), lateral attic wall (scutum), facial nerve canal, tegmen tympani and tegmen mastoideum .
- Dehiscence of lateral semicircular canal.
- Destruction of the mastoid air cells.
- Various complications.

The HRCT findings were tabulated and three set of results were concluded.

1 . First set of results included 50 patients with (n1 = 50) to evaluate according to their age , sex and unilateral/ bilateral disease .

2. 14 out of 50 patients had bilateral disease and 36 had unilateral disease , so a second set of results was concluded with effective number of cases equals to 64 (n2= 64). The second set of results was based upon:

- Side or ear affected
- Clinical symptoms
- HRCT findings –

a) Soft tissue opacification of following parts i.e external ear, middle ear cavity (involving epitympanum, mesotympanum and hypotympanum) ,aditus ad antrum and mastoid air cells .

b) Soft tissue opacification of recesses like prussack's space, facial recess and sinus tympani

c) Bony erosions involving scutum, tegmen tympani, tegmen mastoideum ,mastoid air cells, facial canal , lateral semicircular canal.

d) Erosions involving ossicular chain i.e malleus , incus and stapes.

e) Complications associated with CSOM such as:

- external ear involvement i.e bony erosions of external auditory canal and external ear cholesteatoma formation .
- erosions of petrous apex.
- skull base osteomyelitis .
- fistulous communication between external auditory canal and mastoid antrum (automastoidectomy).
- Facial canal dehiscence

3. Out of 50 patients ,15 underwent surgery , so a third set of results included 15 patients (n3 = 15) to evaluate the correlation between HRCT findings and intraoperative findings.

AGE – In our study the age of the patients ranged from 05 years to 78 years. Maximum number of patients were in the age predominance after after 7^{th} decade of life (20%) and mean age was 41.6 yrs which is similar to findings done by **Rogha et al** [59] who evaluated 36 patients with mean age of 38.2 yrs .

Sex - In our study out of 50 patients, the majority of the cases were males (60%) and 20(40%) were females .The male to female ratio of the study population was 3:2. **Vlastarakos et al** [72] did a study with male:female ratio of 1.6:1, more common in males in accordance with our study .

Side affected– In our study 56.2 % patient had right ear involvement , 48.4% patient had left ear involvement and 28% had bilateral disease . **Chidambaram et al** [73] did a study on 90 patients and concluded that the left side was the most affected in 53.3%, followed by right in 31.1% and bilateral were 15.6%.

In a study done by **Gomaa MA et al** [74]**,** bilateral involvement was noted only in 3.57%.

Clinical presentation.

In our study the chief presenting symptoms were ear discharge seen in 57 (89.1%)patients , decreased hearing in 48 (75%,), earache in 18 (28.1%), headache in 9 (14.1 %),fever in 2 (3.1 %) , tinnitus in 6 (9.4%), vertigo in 3 (4.7%) and post auricular swelling in 1 (1.6 %) patients . Ear discharge was the most common presenting complaint

followed by hearing loss. **Shaik A et al** [75] did a study and concluded that the most common symptom was the foul smelling ear discharge noted in 94 % cases followed by hearing loss in 89 % cases. Tinnitus, vertigo, fever, headache and facial nerve palsy were less common presenting symptoms .

Glasscock et al [76] in his study noted that the majority of symptoms were ear discharge followed by hearing loss. **Thukral CL Singh et al**[42] in their study they noted majority of the symptoms were hearing loss and ear discharge;our study is showing similar results .

HRCT FINDINGS IN CSOM

In our study the most common site of involvement i.e soft tissue opacification in middle ear cavity was epitympanum ,seen in 58(90.6%) followed by mesotympanum in 45(70.3%) cases , in hypotympanum 41 (64.1 %) cases . The involvement of recesses was - facial recess seen in 22(34.4 %) cases, sinus tympani in 24 (37.5 %) cases and prussack's space in 44 (68.8%) cases .In the mastoid part , aditus ad antrum was involved in 52 (81.3 %) cases and mastoid air cells in 61 (95.3 %) cases. External auditory canal is seen in 20 (31.3 %) cases. These findings are in accordance with the study done by **Prakash MD et al** [67] which also revealed that the most common site for cholesteatoma was epitympanum (83.3%) cases. Involvement of mesotympanum and hypotympanum was 43.3% and 6.6% respectively .The aditus ad antrum was involved in 83.3% and mastoid antrum in 76.6%. External auditory canal was involved in 16.6% cases.

In our study on correlating with intraoperative findings, the sensitivity of HRCT to detect soft tissue opacification in epitympanum, mesotympanum , hypotympanum , aditus ad antrum and mastoid air cells was 90%, 92.1% ,100% ,100% and 100% respectively and specificity of 66.6%, 100%, 50,100% and100% respectively .

Our study is in correlation with the studies done by **Sirigiri et al and Bathla et al,**[77,78]which revealed that CT was 100% sensitive for diagnosing cholesteatoma by HRCT images .**O'Donoghue et al** [79] did a study on efficiency of HRCT in defining the extent of disease with

accuracy of 88% .**Mafee et al** [80] did a study on cholesteatoma of middle ear and mastoid and revealed that HRCT accurately depicts the status of the structures of the temporal bone and extent of disease prior to surgery.

Involvement of recesses - In our study the involvement of prussack's space was seen in 68.8% of cases and on correlating with intraoperative findings, the sensitivity and specificity was found to be 100% and 50 % respectively. Involvement of retrotympanum i.e. facial recess and sinus tympani was seen in 34.4% and 37.5% cases and on correlating with intraoperative findings , sensitivity and specificity to detect their involvement is 100% , 66.7% and 60%, 60% respectively. These findings are in accordance with study done by **Gomaa MA et al**[74], which demonstrate the involvement of posterior tympanic recesses i.e. sinus tympani and facial recess by cholesteatoma in 39.3% and 20 % respectively**. V Pramod et al** [69] did a study and revealed that sinus tympani was involved in 66.6% and prussack's space was involved in 40% cases .

Bony erosions – In our study the most common site of bony erosions in middle ear was scutum seen in 41 (64.1%) cases followed by tegmen tympani in 26 (40.6%) cases, incus in 25 (39.1%) cases ,malleus in 13 (20.3%) cases, ,stapes in 13 (20.3%) cases, lateral semicircular canal in 1 (1.56%) case and facial canal in 2 (3.1%) cases. In the mastoid part, most common site for bony erosion was mastoid air cells in 42(65.1%) cases followed by tegmen mastoideum in 5 (7.8%) cases.

On correlating with intraoperative findings, our study revealed sensitivity, specificity, positive predictive value and negative predictive value to detect erosions of scutum on HRCT found to be 100%,62.5%, 70 % and 80% respectively**,** while **Rogha et al** [59] reported sensitivity, specificity , positive predictive value and negative predictive value of scutum erosion to be 96.4 %,87.5% ,96.42% and 87.5% respectively . It was observed that the low specificity in our study may be because of presence of soft tissue in prussack's space which is in close approximation to scutum leading to overdiagnosis of its blunting.

In our study sensitivity, specificity, positive predictive value and negative predictive value to detect tegmen tympani erosion was 100%,62.5%, 70 % and 80% respectively.1case showed discordance (false positive) between HRCT and intraoperative findings.The possible reason to overdiagnose tegmen tympani erosion can be :

- thinned out tegmen tympani as a result of chronic inflammatory process .
- presence of soft tissue in epitympanum .

Sonika Kanotra et al[57] also reported a sensitivity of 100% in detecting tegmen tympani erosion by HRCT which is similar to our study. **O'Donoghue et al.** [79] reported a sensitivity of 50% in identifying tegmen tympani erosion which is partially in accordance with our study.

On correlating with intraoperative findings , sensitivity and specificity to detect ossicular erosion (malleus ,incus and stapes) came out to be 66.6 % and 88.8 % for malleus , 77.7 % and 66.6 % for incus and 50 % and 85.7 % for stapes .

Based on our observations, the most commonly eroded ossicle was the incus which is in accordance with the study done by **Chidambaram et al, Singh, J. & Bhardwaj B. et al and Prakash MD et al** [73,68,67]. **Swartz et al**[81] did a study on 54 patients and reported that sensitivity to detect ossicular erosion was 50% only .

In our study it was observed that the sensitivity to detect the erosion of stapes came out to be 50% which may be because of :

- small size of the bone
- tissue partial volume averaging phenomenon
- soft tissue opacification around the suprastructure.

The sensitivity and specificity to detect bony erosions involving mastoid air cells was 100 % and 100% and tegmen mastoideum was 100 % and 100 % respectively, which is in accordance with study done by **Chidambaram et al** [73]**.**

Complications of chronic suppurative otitis media

In our study the complications seen in patients with CSOM were erosion of bony external auditory canal 3 (4.7%) cases , erosion of

petrous apex seen in 4 (6.3 %) cases, skull base osteomyelitis seen in 4 (6.3%) cases and external ear cholesteatoma was seen in 2 (3.1%) cases .1 patient had developed fistulous communication between external auditory canal and mastoid antrum suggestive of automastoidectomy.

Facial canal dehiscence with involvement of vertical and horizontal segment was seen in 2 (3.1 %) cases and lateral semicircular canal dehiscence was seen in 1(1.56 %) case only.

Chidambaram et al [73] did a study on 90 patients and diagnosed 4 cases of EAC erosion with sensitivity and specificity of 100% on correlating with intraoperative findings.

Gulati et al [82]did a study and revealed complications associated with cholesteatoma were erosion of the facial nerve canal with tympanic/horizontal part being the most frequently affected segment , labyrinthine fistula with lateral semi-circular canal which was most commonly affected due to its close proximity to the middle ear cavity and erosion of lateral mastoid cortex. Extensive destruction of the mastoid cortex and ossicles can occur which may give the appearance similar to postsurgical cases termed as automastoidectomy.

Prasad et al [83] characterized skull base osteomyelitis into lateral and medial temporal bone osteomyelitis, former involves the mastoid and the middle ear cleft and later involves the petrous apex respectively.Lateral temporal bone osteomyelitis is predominantly caused by malignant otitis externa , acute mastoiditis, and suppurative otitis media, while medial temporal bone osteomyelitis is caused predominantly by malignant otitis externa and also by sphenoid sinusitis and skull base infections.

Strengths of the study

1. This is a prospectively conducted study on chronic suppurative otitis media unlike some of the earlier studies on the subject which are retrospective analysis.

Limitations of the study

1. Relatively smaller sample size due to limited duration and covid pandemic.

2. Operative follow up was available in only 15 cases as significant proportion of patients chose non surgical management due to covid pandemic .
3. Due to delay between the HRCT done and surgery performed in few patients, there occurs progression of the disease leading to false negative results .

SUMMARY AND CONCLUSION

1. The present study was conducted at the Department of Radiodiagnosis, Dayanand Medical College and Hospital, Ludhiana.
2. Fifty patients with clinical diagnosis of chronic suppurative otitis media were included in the study which were referred from Department of ENT, Dayanand Medical College and Hospital, Ludhiana.
3. High resolution computed tomography was performed in all 50 cases on 128 slice Seimens CT scanner .
4. 15 patients underwent surgical treatment and correlation was done between HRCT findings and intraoperative findings .
5. The age range of patients was 5 - 78 years with maximum number of patients after 7^{th} decade of their life. The mean age of the patients was 41.6 years .
6. The most common presenting symptom was ear discharge in 89.1% patients followed by hearing loss seen in 75% patients .
7. On HRCT , the most common site for soft tissue opacification in middle ear was epitympanum seen in 90.6% followed by mesotympanum in 70.3% cases and hypotympanum in 64.1% cases .However HRCT cannot differentiate a cholesteatoma from granulation tissue ,pus and fluid which can be present in chronic suppurative otitis media .
8. On HRCT , involvement of prussack's space was seen in 68.8% cases .
9. The involvement of retrotympanum i.e .facial recess and sinus tympani was seen in 34.4 % and 37.5 % respectively .
10. HRCT had high sensitivity to detect bony erosions involving scutum (100%) , tegmen tympani (100%), mastoid air cells(100%) and tegmen mastoideum (100%).
11. Amongst the ossicular erosion, incus was the most commonly eroded ossicle seen in 39.1% cases followed by malleus and stapes seen in 20.3 % cases each.On correlating with

intraoperative findings the incus erosion had the highest sensitivity of 77.7%.

12. On correlating with intraoperative findings, erosion of stapes was diagnosed on HRCT with sensitivity of 50 % only which may be because of tissue partial volume averaging phenomenon and its small size .
13. Labyrinthine fistulae because of lateral semicircular canal involvement was seen in 1(1.6 %) case , which is normally seen in approximately 10% cases .
14. Despite its minimal limitations ,HRCT is the modality of choice in CSOM, to accurately delineate the anatomy of middle ear cleft ,to ascertain extent of the disease , to establish relation with vital structures and to determine complications .

CONCLUSION: HRCT outweighs the other radiological modalities of imaging like xrays and conventional CT.It provides higher spatial resolution in delineating middle ear anatomy and pathology. It is highly accurate to detect soft tissue opacification in middle ear cleft and mastoid and associated bony erosions . It is a valuable imaging modality through which pre-operative assessment of extent of disease can be estimated with reasonable accuracy and helps the surgeon to convert a surgical exploration into a planned procedure.

BIBLIOGRAPHY

1. Davis H, Silverman SR. Hearing and deafness. Holt, Rinehart & Winston of Canada Ltd; 1970.
2. Barath K, Huber AM, Stampfli P, Varga Z, Kollias S. Neuroradiology of cholesteatomas. AJNR Am J Neuroradiol. 2011;32:221–9.
3. Swartz JD, Berger AS, Zwillenberg S, Granoff DW, Popky GL. Synthetic ossicular replacements: normal and abnormal CT appearance. Radiology. 1987;163:766-8.
4. Tono T, Miyanaga S, Morimitsu T, Matsumoto I. Computed tomographic evaluation of middle ear aeration following intact canal wall tympanoplasty. Auris Nasus Larynx. 1987;14:123-30
5. Dhingra PL, Dhingra S, Dhingra D. Anatomy of ear. In diseases of ear, nose and throat & head and neck surgery. 6th edition. Elsevier:New Delhi;2014.p.2-12.
6. Seiden AM, Tami TA, Penssak ML, Cotton RT, Gluckman JL. Otorhinolaryngology, The Essentials. New York, NY: Thieme; 2002. pp. 44–58.
7. Chavada PS, Khavdy PJ, Eefar AD. Mehta MR. Middle ear cholesteatoma: a study of correlation between HRCT temporal bone and intraoperative surgical findings. Int J Otorhinolaryngol Head Neck Surg. 2018:4:1252-7.
8. Jang CH, Wang PC. Preoperative evaluation of bone destruction using threedimensionalComputed tomography in cholesteatoma. J Laryngol Otol. 2004, 118:827-9
9. Maroldi R, Farina D, Palvar ini L, Marconi A, Gadola E, Menni K, et al. Computed tomography and magnetic resonance imaging of pathologic conditions of the middle ear. Eur J Radiol. 2001;40:78-93
10. Hounsfield G: “Computed Medical Imaging” Nobel Lecture At Nobelprize.Org”; 1979.
11. Shaffer KA, Haughton VM, Wilson CR. High resolution computed tomography of the temporal bone. Radiology. 1980;134:409-14.

12. Swartz JD, Harnsberger HR. Imaging of the temporal bone. 3rd ed. New York, NY: Thieme, 1998.
13. Collins JM, Krishnamoorthy AK, Kubal WS, Johnson MH, Poon CS. Multidetector CT of temporal bone fractures. Semin Ultrasound CT MR 2012;33:418–431.
14. Curtin HD, Gupta R, Bergeron RT. Embryology,Anatomy and imaging of the Temporal Bone. In Som PM, Curtin HD (editors). HEAD and NECK IMAGING. 5th edition. publisher Elsevier: St Louis, Missouri ; 2011. p.1053-96
15. Curtin HD, Sanelli PC, Som PM. Temporal bone: embryology and anatomy. Head and neck imaging. 2003;2:1057-75.
16. Donaldson JA, Duckert LG, Lambert PM, Rubel EW. Surgical Anatomy of the Temporal Bone, 4th ed. New York: Raven Press, 1992:19–31
17. Gray's Anatomy, 38th ed. New York: Churchill Livingstone, 1995:1367–1397
18. Smark A. Anatomy and diseases of the temporal bone. In: Atlas SW, ed. Magnetic Resonance Imaging of the Brain and Spine, 2nd ed. Philadelphia: Lippincott-Raven, 1996:998–999
19. Valvanis A, Kubik S, Oguz M. Exploration of the facial nerve canal by high resolution computed tomography: anatomy and pathology. Neuroradiology. 1983; 24:139-47.
20. Chakeres DW, Kapila A. Computed tomography of the temporal bone. Med Radiogr Photogr. 1984;60:1-32.
21. Sadé J, Russo E, Fuchs C, Cohen D. Is secretory otitis media a single disease entity? Ann Otol Rhinol Laryngol. 2003;112:342-7.
22. Manolidis S, Pappas D Jr, Von Doersten P, Jackson CG, Glasscock ME 3rd. Temporal bone and lateral skull base malignancy: experience and results with 81 patients. Am J Otol. 1998 Nov;19(6 Suppl):S1-15.
23. Zielhuis GA, Rach GH, van den Bosch A, van den Broek P. The prevalence of otitis media with effusion: a critical review of the literature. Clin Otolaryngol Allied Sci. 1990 Jun;15:283-8.

24. Williamson I. Otitis media with effusion. Clin Evid. 2006;(15):814-21.
25. Swartz JD. Cholesteatomas of the middle ear. Diagnosis, etiology, and complications. Radiol Clin North Am. 1984;22:15-35.
26. Ibekwe TS, Nwaorgu OG: Classification and management challenges of otitis media in a resource-poor country. Niger J Clin Pract, 2011;14:262–69.
27. Juliano AF, Ginat DT, Moonis G: Imaging review of the temporal bone: Part I. Anatomy and inflammatory and neoplastic processes. Radiology, 2013;269:17–33.
28. Sreedhar S, Pujary K, Agarwal AC, Balakrishnan R: Role of high-resolution computed tomography scan in the evaluation of cholesteatoma: A correlation of high-resolution computed tomography with intra-operative findings. Indian J Otol, 2015;21: 103–6.
29. Eshetu T, Aygun N: Imaging of the temporal bone: A symptom-based approach. Semin Roentgenol, 2013;48:52–64.
30. Swartz JD, Mandell DW, Berman SE, Wolfson RJ, Marlowe Fl, Popky GL. Cochlear Otosclerosis (Otospongiosis): CT analysis with audiometric correlation. Radiology. 1985;155:147–50.
31. Swartz JD, Goodman RS, Russell KB, Marlowe Fl, Wolfson RJ. High-Resolution computed tomography of the middle ear and mastoid. Part II: Tubotympanic Disease. Radiology. 1983;148:455–9.
32. Johnson DW, Voorhees RL, Lufkin RB, Hanafee W, Canalis R. Cholesteatomas of the temporal bone: role of computed tomography. Radiology. 1983;148:733–7.
33. Mafee MF, Aimi K, Kahen HL, Valvassori GE, Capek V. Chronic otomastoiditis: A conceptual understanding of CT findings. Radiology. 1986;160:193–200.
34. Zizmor J, Noyek AM. Inflammatory diseases of the temporal bone. Radiol Clin North Am. 1974;12:491-504.

35. Jackler RK, Dillon WP, Schindler RA. Computerized tomography in suppurative ear disease: a correlation of surgical and radiographic findings. Laryngoscope.1984;94:746-52.
36. Baráth K, Huber AM, Stämpfli P, Varga Z, Kollias S. Neuroradiology of cholesteatomas. AJNR Am J Neuroradiol. 2011;32:221-9.
37. Rosito LS, Netto LF, Teixeira AR, Da Costa SS: Classification of cholesteatoma according to growth patterns. JAMA Otolaryngol Head Neck Surg, 2016;142:168–72.
38. Corrales CE, Blevins NH: Imaging for evaluation of cholesteatoma: Current concepts and future directions. Curr Opin Otolaryngol Head Neck Surg, 2013;21:461–67.
39. Bukurov B, Babić B, Dimitrijević M, Folić M, Arsović N. Congenital cholesteatoma of the middle ear--uncommon clinical presentation. Vojnosanit Pregl. 2014;71(5):503-5.
40. Anbarasu A, Chandrasekaran K, Balakrishnan S: Soft tissue attenuation in middle ear on HRCT: Pictorial review. Indian J Radiol Imaging,2012; 22: 298–304.
41. McGuire JK, Wasl H, Harris T, Copley GJ, Fagan JJ. Management of pediatric cholesteatoma based on presentations, complications, and outcomes. Int J Pediatr Otorhinolaryngol. 2016;80:69-73.
42. Thukral CL, Singh A, Singh S, Sood AS, Singh K. Role of High Resolution Computed Tomography in Evaluation of Pathologies of Temporal Bone. J Clin Diagn Res. 2015;9(9):TC07-10.
43. Trojanowska, A., Drop, A., Trojanowski, P. *et al.* External and middle ear diseases: radiological diagnosis based on clinical signs and symptoms. *Insights Imaging* 3, 33–48 (2012).
44. Kumar SS, Thakar A: Spectrum of facial paralysis in chronic suppurative otitis media. Indian J Otol, 2012;18:92–94.
45. Maranhão A, Andrade J, Godofredo V et al: Epidemiology of intratemporal complications of otitis media. Int Arch Otorhinolaryngol, 2014;18:178–83.
46. Sennaroglu L, Sozeri B. Otogenic brain abscess: review of 41 cases. Otolaryngol Head Neck Surg, 2000;123:751–5.

47. Ryan JT, Pena M, Zalzal GH, Preciado DA: Otogenic lateral sinus thrombosis in children: A review of 7 cases. Ear Nose Throat J, 2016;95:108–12.
48. Gurung UA, Ullah KS, Shrivastav RP, Bhattarai H: Otitic hydrocephalus. Indian J Otol, 2011;17:167–69.
49. Pradhananga R: An unusual complication of chronic suppurative otitis media: Bezold abscess progressing to scapular abscess. Int Arch Otorhinolaryngol, 2014;18:412–14.
50. Comparison of preoperative computerized tomography scan imaging of temporal bone with the intra-operative findings in patients undergoing mastoidectomy. Gerami H, Naghavi E, Wahabi-Moghadam M, Forghanparast K, Akbar MH. Saudi Med J. 2009; 30:104-8.
51. The role of preoperative CT scan in patients with chronic otitis media. Alzoubi FQ, Odat HA, Al-Balas HA, Saeed SR. Eur Arch Otorhinolaryngol. 2009;266:807-9.
52. Multispiral computed tomography for the assessment of the extent of surgical intervention in patients with chronic suppurative otitis media. Dobrotin VE, Shekhter AI, Bodrova IV. VestnOtorinolaringol.2009;(4):18-22.
53. Sethom A, Akkari K, Dridi I, Tmimi S, Mardassi A, Benzarti S, et al. Preoperative CT Scan in middle ear cholesteatoma. Tunis Med. 2011;89:248-53.
54. Sun XW, Zhang JJ, Ding YP, Dou FF, Zhang HB, Gong KB, et al. Efficacy of high-resolution CT in differential diagnosis of chronic suppurative otitis media and cholesteatoma otitis media by soft-tissue shadows. Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 2011;46:388-92.
55. Tatlipinar A, Tuncel A, Öğredik EA, Gökçeer T, Uslu C. The role of computed tomography scanning in chronic otitis media. European Archives of Oto-Rhino-Laryngology. 2012;269:33-8.

56. Yildirim-Baylan M, Ozmen CA, Gun R, Yorgancilar E, Akkuş Z, Topcu I. An evaluation of preoperative computed tomography on patients with chronic otitis media. Indian J Otolaryngol Head Neck Surg. 2012;64:67-70.
57. Kanotra S, Gupta R, Gupta N, Sharma R, Gupta S, Kotwal S. Correlation of high-resolution computed tomography temporal bone findings with intra-operative findings in patients with cholesteatoma. Indian Journal of Otology. 2015;21:280-5.
58. Rai T. Radiological study of the temporal bone in chronic otitis media: Prospective study of 50 cases. Indian J Otol. 2014;20:48-55.
59. Rogha M, Hashemi SM, Mokhtarinejad F, Eshaghian A, Dadgostar A. Comparison of preoperative temporal bone CT with intraoperative findings in patients with cholesteatoma. Iran J Otorhinolaryngol. 2014;26:7-12.
60. Sunitha M, Asokan L, Sambandan AP. A comparative study of plain x-ray mastoids with HRCT temporal bone in patients with chronic suppurative otitis media. Journal of Evolution of Medical and Dental Sciences. 2015;4:5190-8.
61. Chatterjee P, Khanna S, Talukdar R. Role of high resolution computed tomography of mastoids in planning surgery for chronic suppurative otitis media. Indian J Otolaryngol Head Neck Surg. 2015;67:275-80.
62. Vallabhaneni R, Srinivasa Babu CR. HRCT temporal bone findings in CSOM: our experience in rural population of South India. IOSR J Dent Med Sci. 2016;15:49-53
63. Boruah DK, Sharma BK, Sanyal S, Malakar N, Dhingani DD, Prakash A et al. Role of high resolution computed tomography in the evaluation of suppurative diseases of middle ear and mastoids and their complications with surgical correlation. J Evol Med Dent Sci. 2016;5:850-8.
64. Tak J, Khilnani AK. Role of high resolution computed tomography of temporal bone in management of chronic suppurative otitis media. Int J Otorhinolaryngol Head Neck Surg. 2016 Oct;2(4):193-6.

65. Sharma VK, Prajapati N, Sharma R, Iqbal Z, Dadoo S. Radiological changes in anatomy of temporal bone in cases of unsafe chronic suppurative otitis media: A retrospective study. Indian J Otol. 2017;23:176-9.
66. Happani H, Kalola J, Rathod H, Trivedi A. Role of HRCT Temporal Bone In Patients with Chronic Supparative Otitis Media. Radiology. 2018;3:C70-2.
67. Prakash MD, Tarannum A. Role of high resolution computed tomography of temporal bone in preoperative evaluation of chronic suppurative otitis media. Int J Otorhinolaryngol Head Neck Surg. 2018;4:1287-92
68. Singh J, Bhardwaj B. How Efficacious is HRCT Temporal Bone in Determining the Ossicular Erosion in Cases of Safe and Limited Squamous Type CSOM? Indian J Otolaryngol Head Neck Surg. 2019;71(Suppl 2):1179-1182.
69. Pramod V, Raghuraj U, Shrikrishna U. Intraoperative and HRCT Findings Correlation in Chronic Suppurative Otitis Media. JMSCR. 2020;8:613-22.
70. Singh R, Rai R, Singh P, Sethi S, Ahluwalia APS, Choudhary G. High-resolution computed tomography (HRCT) in pediatric and adult patients with unsafe chronic suppurative otitis media (CSOM) and its surgical correlation. J Family Med Prim Care. 2020;9(8):4067-73.
71. Rehman A, Khan R, Wani AA, Ali A, Mir F, Salroo IN. Correlation of preoperative HRCT temporal bone with intraoperative findings in unsafe csom:- statistical analysis. IJCAR;2021:24200-4.
72. Vlastarakos PV, Kiprouli C, Pappas S, Xenelis J, Maragoudakis P, Troupis G, et al. CT scan versus surgery: how reliable is the preoperative radiological assessment in patients with chronic otitis media? Eur Arch Otorhinolaryngol 2012;269(1):81-6.
73. Chidambaram1 PK, Rajkumar VV, Vinayagam S, Aiyappan SK, Karpagam B. High Resolution CT Imaging in Pathologies of Temporal Bone. IJCMR. 2019;4:C11-C17.

74. Gomaa MA, Karim AR, Ghany HS, Elhiny AA, Sadek AA. Evaluation of temporal bone cholesteatoma and the correlation between high resolution computed tomography and surgical finding. Clin Med Insights Ear Nose Throat. 2013:6 ; 21-8
75. Shaik A, Kulkarni NK, Hanumanthrao AVS. Clinical and radiological study of atticoantral type of chronic suppurative otitis media. J Evolution Med Dent Sci 2020;9(51):3837-3840
76. Glasscock ME 3rd, Dickins JR, Wiet R. Cholesteatoma in children. Laryngoscope 1981;91(10):1743-53.
77. Sirigiri RR, Dwaraknath K. Correlative study of HRCT in attico-antral disease. Indian J Otolaryngol Head Neck Surg. 2011;63(2):155–8.
78. M Bathla, H Doshi, A Kansara. Is Routine Use of High Resolution Computerized Tomography of Temporal Bone in Patients of Atticoantral Chronic Suppurative Otitis Media without Intracranial Complications Justified? Indian J Otolaryngol Head Neck Surg 2018;70(1):79-86.
79. O'Donoghue GM, Bates GJ, Anslow P, Rothera MP. The predictive value of high resolution computerized tomography in chronic suppurative ear disease. Clin Otolaryngol Allied Sci. 1987;12:89-96.
80. Mafee MF, Levin BC, Applebaum EL, Campos M, James CF. Cholesteatoma of the middle ear and mastoid. A comparison of CT scan and operative findings. Otolaryngol Clin North Am. 1988;21:265-93.
81. Swartz JD. Cholesteatomas of the middle ear. Diagnosis, etiology, and complications. Radiologic Clinics of North America. 1984;22:15-35
82. Gulati M, Gupta S, Prakash A, Garg A, Dixit R. HRCT imaging of acquired cholesteatoma: a pictorial review. Insights Imaging. 2019;10:92.
83. Prasad SC, Prasad KC, Kumar A, Thada ND, Rao P, Chalasani S, et al. Osteomyelitis of the temporal bone: Terminology, diagnosis, and management. J Neurol Surg B Skull Base 2014;75:324-31.

KEY TO MASTER CHART

	ABBREVIATIONS
A	ABSENT
CSOM	CHRONIC SUPPURATIVE OTITIS MEDIA
D/S	EAR DISCHARGE
EAC	EXTERNAL AUDITORY CANAL
LSCC	LATERAL SEMICIRCULAR CANAL
L	LEFT
P	PRESENT
R	RIGHT
ST	SOFT TISSUE
STO	SOFT TISSUE OPACIFICATION
TM	TYMPANIC MEMBRANE

S No.	MRD NO.	NAME	AGE	SEX	DIAGNOSIS ON CT	AFFECTED EAR	CLINICAL SYMPTOMS								OPERATIVE STATUS						
							EAR DISCHARGE	HEARING LOSS	EAR ACHE	HEADACHE	FEVER	VERTIGO	TINNITUS	POST AURICULAR SWELLING	OPERATED OR NOT	ST IN EAC	RETRACTION OR PERFORATION OF TM	STO IN EPITYMPANUM	STO in MESOTYMPANUM	STO in HYPOTYMPANUM	ST in PRUSSACK'S SPACE
1	874638	PK	40	F	B/L CSOM	RIGHT	+	+	-	+	-	+	-	-	NOT OPERATED	P	A	P	P	P	P
2	874638	PK				LEFT	-	-	-	-	-	-	-	-	NOT OPERATED	A	A	P	P	P	P
3	873644	JK	68	F	U/L (LCSOM)	LEFT	+	+	+	+	-	-	-	-	NOT OPERATED	A	P	P	P	P	P
4	881424	GS	20	M	B/L CSOM	RIGHT	+	+	+	+	-	+	+	-	OPERATED ON R	A	P	P	A	A	P
5	881424	GS				LEFT	+	-	-	-	-	-	-	-	NOT OPERATED	A	P	P	P	P	P
6	879670	SK	60	M	U/L (RCSOM)	RIGHT	+	+	+	+	-	-	-	-	NOT OPERATED	A	P	P	P	P	P
7	885720	S	50	F	B/L CSOM	RIGHT	+	+	+	+	-	-	-	+	NOT OPERATED	A	A	P	P	P	P
8	885720	S				LEFT	-	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	A	A	P
9	877194	jr	65	M	B/L CSOM	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	P	P	P
10	877194	jr				LEFT	+	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	P	P	P
11	879005	RS	63	M	U/L (RCSOM)	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	A	A	A
12	901687	PS	46	M	U/L (RCSOM)	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	A	A	A
13	581678	HK	21	F	U/L (RCSOM)	RIGHT	+	-	+	-	+	-	-	-	NOT OPERATED	A	A	P	A	A	A
14	879906	PK	70	F	U/L (LCSOM)	LEFT	+	-	-	+	-	-	-	-	NOT OPERATED	P	P	P	P	P	A
15	902889	MK	52	F	B/L CSOM	RIGHT	+	-	-	+	+	-	-	-	NOT OPERATED	A	P	P	P	P	A
16	902889	MK				LEFT	-	-	-	-	-	-	-	-	NOT OPERATED	A	A	P	P	P	P
17	911820	SP	45	M	U/L (LCSOM)	LEFT	+	+	-	-	-	-	+	-	NOT OPERATED	A	A	P	A	A	A
18	885472	MS	40	M	U/L (LCSOM)	LEFT	+	+	-	-	-	-	+	-	NOT OPERATED	A	TM THICKENED	P	P	P	A
19	769680	RS	50	M	U/L (RCSOM)	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	P	P	P	P	P	P
20	942718	SS	55	M	U/L (RCSOM)	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	P	P	P	P	P	P
21	941218	NK	48	F	U/L (RCSOM)	RIGHT	+	-	-	-	-	-	-	-	NOT OPERATED	P	P	P	P	P	A
22	394958	HK	5	F	U/L (LCSOM)	LEFT	+	-	-	-	-	-	-	-	NOT OPERATED	P	P	P	A	A	A
23	970553	JS	10	M	B/L CSOM	RIGHT	+	+	+	-	-	-	-	-	OPERATED ON R	A	A	A	P	P	P
24	970553	JS				LEFT	+	+	+	-	-	-	-	-	NOT OPERATED	A	A	P	P	P	P
25	386945	SB	55	M	B/L CSOM	RIGHT	-	+	-	-	-	-	-	-	OPERATED ON R	A	P	P	P	P	P
26	386945	SB				LEFT	-	+	-	-	-	-	-	-	NOT OPERATED	A	P	P	A	P	P
27	1009026	PG	28	F	B/L CSOM	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	P	TM THICKENED	P	P	A	P
28	1009026	PG				LEFT	+	+	-	-	-	-	-	-	NOT OPERATED	A	P	P	P	P	P
29	861872	RB	39	F	B/L CSOM	RIGHT	+	+	-	-	-	-	+	-	NOT OPERATED	A	A	P	P	P	P
30	861872	RB				LEFT	+	+	-	-	-	-	+	-	NOT OPERATED	A	A	P	P	P	P
31	100449	S	42	M	B/L (CSOM)	LEFT	+	+	-	-	-	-	-	-	OPERATED ON L	P	A	A	A	A	A
32	100449	S				RIGHT	-	-	-	-	-	-	-	-	NOT OPERATED	P	A	A	A	A	A
33	1029535	S	14	M	B/L CSOM	RIGHT	+	+	-	-	-	-	-	-	OPERATED ON R	P	P	P	P	P	P
34	1029535	S				LEFT	-	-	-	-	-	-	-	-	NOT OPERATED	A	A	A	A	A	A
35	1032080	R	28	M	U/L (RCSOM)	RIGHT	+	-	-	-	-	-	-	-	NOT OPERATED	P	P	A	A	A	P
36	1023009	N	28	M	B/L CSOM	LEFT	+	+	-	-	-	-	-	-	OPERATED ON R	A	TM THICKENED	P	P	P	P
37	1023009	N				RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	A	A	A
38	1033520	BS	78	M	U/L (RCSOM)	RIGHT	+	+	-	+	-	-	-	-	NOT OPERATED	P	P	P	P	A	A
39	836280	JS	53	M	U/L (RCSOM)	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	P	P	P	P	P	P
40	1044630	GK	20	F	B/L CSOM	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	P	P	P
41	1044630	GK				LEFT	+	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	A	A	A
42	1037511	HS	65	M	U/L (LCSOM)	LEFT	+	+	+	-	-	-	-	-	NOT OPERATED	P	A	P	P	P	A
43	1048051	A	44	F	U/L (RCSOM)	RIGHT	+	-	-	-	-	-	-	-	NOT OPERATED	A	P	P	P	P	P
44	1062344	RS	77	M	U/L (LCSOM)	LEFT	+	+	+	-	-	-	-	-	NOT OPERATED	P	P	P	P	P	P
45	1066016	PS	45	M	U/L (RCSOM)	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	A	A	P
46	1072556	G	38	M	U/L (RCSOM)	RIGHT	+	+	-	-	-	+	-	-	NOT OPERATED	P	A	P	P	P	P
47	1074802	JS	63	M	U/L (LCSOM)	LEFT	+	+	-	-	-	-	-	-	NOT OPERATED	A	P	P	P	P	P

S No.	MRD NO.	HRCT TEMPORAL BONE FINDINGS													OTHER COMPLICATIONS ON HRCT
		STO in FACIAL RECESS	STO in SINUS TYMPANI	STO in ADITUS AD ANTRUM	STO in OPACIFICATION OF MASTOID	EROSIONS OF SCUTUM	EROSIONS OF MALLEUS	EROSIONS OF INCUS	EROSIONS OF STAPES	EROSIONS OF MASTOID AIR CELLS	EROSIONS OF LSCC	EROSIONS OF TEGMEN TYMPANI	EROSIONS OF TEGMEN MASTOIDEUM	EROSION OF FACIAL CANAL	OTHER COMPLICATIONS
1	874638	P	P	P	P	P	A	A	A	P	A	A	A	A	-
2	874638	A	A	P	P	P	A	A	A	P	A	A	A	A	-
3	873644	P	A	P	P	P	A	A	P	P	A	A	A	A	-
4	881424	A	A	P	P	P	P	P	A	P	A	A	A	A	-
5	881424	A	A	P	P	P	P	P	A	P	A	A	A	A	-
6	879670	A	A	P	P	P	P	P	A	P	A	P	A	A	SKULL BASE OSTEOMYELITIS
7	885720	A	P	P	P	A	A	A	A	P	A	P	P	P	SKULL BASE OSTEOMYELITIS
8	885720	A	A	P	P	A	A	A	A	P	A	P	A	A	-
9	877194	A	P	P	P	A	A	A	A	P	A	P	A	A	-
10	877194	A	P	P	P	A	A	A	A	P	A	P	A	A	-
11	879005	A	A	P	P	A	A	A	A	P	A	A	A	A	-
12	901687	A	A	P	P	A	A	A	A	P	A	A	A	A	-
13	581678	A	A	P	P	P	A	A	A	P	A	A	A	A	-
14	879906	A	A	P	P	P	A	A	A	A	A	A	A	A	EROSIONS OF EXTERNAL AUDITORY CANAL. EXTERNAL EAR CHOLESTEATOMA
15	902889	A	A	P	P	A	A	A	A	A	A	A	A	A	-
16	902889	A	A	P	P	A	A	A	A	A	A	A	A	A	-
17	911820	A	A	A	P	A	P	A	A	A	A	A	A	A	-
18	885472	A	A	A	P	A	A	A	A	A	A	P	A	A	-
19	769680	A	A	P	P	P	A	A	A	P	A	P	A	A	EROSIONS OF PETROUS APEX. SKULL BASE OSTEOMYELITIS
20	942718	A	A	A	P	P	A	A	A	P	A	P	A	A	-
21	941218	P	P	P	P	P	A	A	A	P	A	A	A	A	-
22	394958	A	A	A	A	A	A	A	A	A	A	A	A	A	-
23	970553	P	P	A	P	P	A	A	P	P	A	A	A	A	-
24	970553	P	P	A	P	P	A	A	P	P	A	A	A	A	-
25	386945	P	P	P	P	P	P	A	A	A	A	A	A	A	-
26	386945	A	P	P	P	A	A	A	A	A	A	A	A	A	-
27	1009026	P	P	P	P	P	A	P	A	A	A	P	A	A	-
28	1009026	P	P	P	P	A	P	P	A	A	A	A	A	A	-
29	861872	A	A	P	P	P	A	P	P	P	A	A	A	A	-
30	861872	A	A	P	P	P	A	P	P	P	A	A	A	A	-
31	100449	A	A	P	P	A	A	A	A	P	A	A	A	A	EXTERNAL EAR CHOLESTEATOMA
32	100449	A	A	P	P	A	A	A	A	P	A	A	A	A	EROSION OF EXTERNAL AUDITORY CANAL.
33	1029535	A	A	P	P	P	P	P	A	P	A	P	A	A	-
34	1029535	A	A	A	A	A	A	A	A	P	A	A	A	A	-
35	1032080	A	A	A	P	P	A	A	A	A	A	A	A	A	-
36	1023009	P	P	P	P	P	A	P	A	A	A	P	A	A	-
37	1023009	A	A	A	P	A	A	A	A	A	A	A	A	A	-
38	1033520	A	A	A	A	P	P	P	P	P	A	P	A	A	EROSIONS OF PETROUS APEX. SKULL BASE OSTEOMYELITIS
39	836280	P	P	P	P	P	A	P	P	P	A	P	A	A	U/L (RCSOM) WITH FISTULOUS COMMUNICATION BTW EAC AND MASTOID ANTRUM
40	1044630	A	P	P	P	P	A	P	A	P	A	A	A	A	-
41	1044630	A	A	P	P	P	A	A	A	A	A	A	A	A	-
42	1037511	A	A	A	P	A	A	A	A	P	A	P	A	P	EROSION OFPETROUS APEX AND EXTERNAL AUDITORY CANAL. INVOLVEMENT OF VERTICAL SEGMENT OF FACIAL CANAL.
43	1048051	A	A	P	P	P	A	A	A	A	A	P	A	A	-
44	1062344	P	P	P	P	P	A	P	A	A	A	A	A	A	-
45	1066016	P	P	P	P	P	A	P	P	A	A	P	A	A	-
46	1072556	P	P	P	P	P	P	P	A	A	P	A	A	A	-
47	1074802	P	A	P	P	P	A	A	A	P	A	P	A	A	-

S No.	MRD NO.	NAME	AGE	SEX	DIAGNOSIS ON CT	AFFECTED EAR	CLINICAL SYMPTOMS								OPERATIVE STATUS						
							EAR DISCHARGE	HEARING LOSS	EAR ACHE	HEADACHE	FEVER	VERTIGO	TINNITUS	POST AURICULAR SWELLING	OPERATED OR NOT	ST IN EAC	RETRACTION OR PERFORATION OF TM	STO IN EPITYMPANUM	STO in MESOTYMPANUM	STO in HYPOTYMPANUM	ST in PRUSSACK'S SPACE
48	1078415	HS	59	M	U/L (LCSOM)	LEFT	+	+	+	-	-	-	-	-	NOT OPERATED	P	P	P	P	P	P
49	792093	M	50	F	B/L CSOM	RIGHT	+	+	-	-	-	-	-	-	NOT OPERATED	A	P	P	P	P	P
50	792093	M				LEFT	+	+	-	-	-	-	-	-	NOT OPERATED	A	A	P	A	A	A
51	1072662	N	17	F	U/L (RCSOM)	RIGHT	+	+	+	+	-	-	-	-	NOT OPERATED	A	A	A	A	A	A
52	1119823	HS	45	M	U/L (LCSOM)	LEFT	+	+	+	-	-	-	-	-	NOT OPERATED	A	P	P	A	A	P
53	1114212	PK	62	F	U/L (LCSOM)	LEFT	+	+	-	-	-	-	-	-	NOT OPERATED	P	P	P	P	A	P
54	1159763	J	35	M	U/L (LCSOM)	LEFT	+	-	-	-	-	-	-	-	NOT OPERATED	P	P	P	P	P	P
55	6741	SS	42	M	U/L (RCSOM)	RIGHT	+	+	+	-	-	-	-	-	NOT OPERATED	A	P	P	P	P	P
56	741019	JK	14	F	U/L (LCSOM)	LEFT	+	+	+	-	-	-	-	-	OPERATED ON L	**A**	P	P	A	A	P
57	381443	VK	62	M	U/L (LCSOM)	LEFT	+	-	+	-	-	-	-	-	OPERATED ON L	A	A	P	P	A	A
58	23322	GK	38	F	U/L (LCSOM)	LEFT	+	+	-	-	-	-	+	-	OPERATED ON L	A	TM THICKENED	P	P	A	P
59	601061	RK	24	F	U/L (RCSOM)	RIGHT	+	+	+	-	-	-	-	-	OPERATED ON R	A	P	P	P	P	P
60	984576	AK	33	F	U/L (RCSOM)	RIGHT	+	-	-	-	-	-	-	-	OPERATED ON R	A	P	P	P	P	A
61	1079874	KK	30	F	U/L (RCSOM)	RIGHT	+	+	-	-	-	-	-	-	OPERATED ON R	A	P	P	P	P	P
62	1140394	JS	70	M	U/L (LCSOM)	LEFT	+	+	+	-	-	-	-	-	OPERATED ON L	P	P	A	P	P	P
63	881424	GS	21	M	U/L (LCSOM)	LEFT	+	+	+	-	-	-	-	-	OPERATED ON L	A	P	P	P	P	P
64	1157745	MS	26	M	U/L (RCSOM)	RIGHT	+	-	-	-	-	-	-	-	OPERATED ON R	A	P	P	P	P	P

S No.	MRD NO.	HRCT TEMPORAL BONE FINDINGS													OTHER COMPLICATIONS ON HRCT
		STO in FACIAL RECESS	STO in SINUS TYMPANI	STO in ADITUS AD ANTRUM	STO in OPACIFICATION OF MASTOID	EROSIONS OF SCUTUM	EROSIONS OF MALLEUS	EROSIONS OF INCUS	EROSIONS OF STAPES	EROSIONS OF MASTOID AIR CELLS	EROSIONS OF LSCC	EROSIONS OF TEGMEN TYMPANI	EROSIONS OF TEGMEN MASTOIDEUM	EROSION OF FACIAL CANAL	OTHER COMPLICATIONS
48	1078415	P	P	P	P	P	A	A	A	P	A	P	P	A	-
49	792093	A	A	P	P	P	P	P	A	P	A	P	A	A	-
50	792093	A	A	P	P	P	A	P	A	P	A	P	A	A	-
51	1072662	A	A	A	P	A	P	P	P	P	A	A	A	A	-
52	1119823	A	A	P	P	P	A	P	A	A	A	P	A	A	-
53	1114212	P	P	P	P	P	A	A	A	A	A	A	A	A	
54	1159763	P	P	P	P	P	A	A	A	P	A	P	P	A	-
55	6741	P	P	P	P	P	A	A	A	P	A	P	P	A	-
56	741019	A	A	P	P	A	A	P	P	A	A	A	A	A	-
57	381443	P	A	P	P	P	A	P	P	P	A	A	A	A	-
58	23322	A	A	P	P	A	A	A	A	A	A	A	A	A	-
59	601061	P	P	P	P	P	A	P	A	P	A	P	A	A	-
60	984576	A	A	P	P	A	A	A	A	P	A	A	A	A	-
61	1079874	P	P	P	P	P	A	P	A	P	A	P	A	A	-
62	1140394	P	P	P	P	P	A	A	P	P	A	P	A	A	EROSION OFPETROUS APEX AND EROSION OF EXTERNAL AUDITORY CANAL
63	881424	A	A	P	P	A	P	P	P	P	A	A	P	A	-
64	1157745	A	A	P	P	P	P	P	A	P	A	A	A	A	-

S N0.	MRD NO.	NAME	AGE	SEX	DIAGNOSIS ON CT	AFFECTED EAR	CLINICAL SYMPTOMS								EAR OPERATED	ST IN EAC	RETRACTION OR PERFORATION OF TM	STO IN EPITYMPANUM	STO IN MESOTYMPANUM	STO IN HYPOTYMPANUM	ST IN PRUSSACK'S SPACE
							EAR D/S	HEARING LOSS	EAR ACHE	HEADACHE	FEVER	VERTIGO	TINNITUS	POST AURICULAR SWELLING							
1	741019	JK	14	F	LEFT CSOM	LEFT	+	+	+	-	-	-	-	-	OPERATED ON L	**A/A**	P/P	P/P	A/P	A/P	P/P
2	381443	VK	62	M	LEFT CSOM	LEFT	+	-	+	-	-	-	-	-	OPERATED ON L	A/A	A/P	P/P	P/P	A/P	A/A
3	881424	GS	20	M	B/L CSOM	RIGHT	+	+	+	+	-	+	+	-	OPERATED ON R	A/A	P/P	P/P	A/A	A/A	P/P
4	23322	GK	38	F	LEFT CSOM	LEFT	+	+	-	-	-	-	+	-	OPERATED ON L	A/A	TM THICKENED	P/P	P/P	A/A	P/A
5	970553	JS	10	M	B/L CSOM	RIGHT	+	+	+	-	-	-	-	-	OPERATED ON R	A/A	A/A	A/P	P/P	P/P	P/P
6	601061	RK	24	F	RIGHT CSOM	RIGHT	+	+	+	-	-	-	-	-	OPERATED ON R	A/A	P/P	P/P	P/P	P/A	P/P
7	386945	SB	55	M	B/L CSOM	RIGHT	-	+	-	-	-	-	-	-	OPERATED ON R	A/A	P/P	P/P	P/P	P/P	P/A
8	984576	AK	33	F	RIGHT CSOM	RIGHT	+	-	-	-	-	-	-	-	OPERATED ON R	A/A	P/P	P/P	P/P	P/P	A/A
9	100449	S	42	M	LEFT CSOM	LEFT	+	+	-	-	-	-	-	-	OPERATED ON L	P/P	A/A	A/A	A/A	A/A	A/A
10	1029535	S	14	M	RIGHT CSOM	RIGHT	+	+	-	-	-	-	-	-	OPERATED ON R	P/P	P/P	P/P	P/P	P/P	P/P
11	1023009	N	28	M	B/L CSOM	LEFT	+	+	-	-	-	-	-	-	OPERATED ON L	A/A	TM THICKENED	P/A	P/P	P/P	P/P
12	1079874	KK	30	F	RIGHT CSOM	RIGHT	+	+	-	-	-	-	-	-	OPERATED ON R	A/A	P/P	P/P	P/P	P/P	P/P
13	1140394	JS	70	M	LEFT CSOM	LEFT	+	+	+	-	-	-	-	-	OPERATED ON L	P/P	P/P	A/A	P/P	P/P	P/P
14	881424	GS	21	M	LEFT CSOM	LEFT	+	+	+	-	-	-	-	-	OPERATED ON L	A/A	P/A	P/P	P/P	P/P	P/A
15	1157745	MS	26	M	RIGHT CSOM	RIGHT	+	-	-	-	-	-	-	-	OPERATED ON R	A/A	P/P	P/P	P/P	P/P	P/P

S N0.	MRD NO.	HRCT TEMPORAL BONE FINDINGS / INTRAOPERATIVE FINDINGS													OTHER COMPLICATIONS ON HRCT
		STO IN FACIAL RECESS	STO IN SINUS TYMPANI	STO IN ADITUS AD ANTRUM	STO OF MASTOID	EROSIONS OF SCUTUM	EROSIONS OF MALLEUS	EROSIONS OF INCUS	EROSIONS OF STAPES	EROSIONS OF MASTOID AIR CELLS	EROSIONS OF LSCC	EROSIONS OF TEGMEN TYMPANI	EROSIONS OF TEGMEN MASTOIDEUM	EROSION OF FACIAL CANAL	OTHER COMPLICATIONS
1	741019	A/P	A/P	P/P	P/P	A/A	A/A	P/P	P/P	A/A	A/A	A/A	A/A	A/A	-
2	381443	P/A	A/P	P/P	P/P	P/A	A/A	P/P	P/P	P/P	A/A	A/A	A/A	A/A	-
3	881424	A/A	A/A	P/P	P/P	P/P	P/P	P/P	A/A	P/P	A/A	A/A	A/A	A/A	-
4	23322	A/A	A/A	P/P	P/P	A/A	A/P	A/P	A/A	A/A	A/A	A/A	A/A	A/A	-
5	970553	P/P	P/P	A/A	P/P	P/A	A/A	A/A	P/A	P/P	A/A	A/A	A/A	A/A	-
6	601061	P/A	P/A	P/P	P/P	P/P	A/A	P/A	A/A	P/P	A/A	P/P	A/A	A/A	-
7	386945	P/A	P/A	P/P	P/P	P/P	P/A	A/P	A/P	A/A	A/A	A/A	A/A	A/A	-
8	984576	A/A	A/A	P/P	P/P	A/A	A/A	A/A	A/A	P/P	A/A	A/A	A/A	A/A	-
9	100449	A/A	A/A	P/P	P/P	A/A	A/A	A/A	A/A	P/P	A/A	A/A	A/A	A/A	EXTERNAL EAR CHOLESTEATOMA
10	1029535	A/P	A/P	P/P	P/P	P/P	P/P	P/P	A/P	P/P	A/A	P/P	A/A	A/A	-
11	1023009	P/A	P/A	P/P	P/P	P/P	A/P	P/A	A/P	A/A	A/A	P/A	A/A	A/A	-
12	1079874	P/P	P/P	P/P	P/P	P/P	A/A	P/P	A/A	P/P	A/A	P/P	A/A	A/A	-
13	1140394	P/P	P/P	P/P	P/P	P/P	A/A	A/A	P/P	P/P	A/A	P/P	A/A	A/A	EROSION OF PETROUS APEX AND EXTERNAL AUDITORY CANAL
14	881424	A/A	A/A	P/P	P/P	A/A	P/P	P/P	P/P	P/P	A/A	A/A	P/P	A/A	-
15	1157745	A/A	A/A	P/P	P/P	P/A	P/P	P/P	A/P	P/P	A/A	A/A	A/A	A/A	-

Baba Farid University
of Health Sciences
Sadiq Road
Faridkot-151 203 (Pb). INDIA.
Phone : 01639-256232,256236
Tele/Fax : 01639-256235
Email – Examination@bfuhs.ac.in

No. BFUHS/2K21p-TH/ 5049 Date 20/4/2021

The Principal,
DMC,Ludhiana

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 22.01.2021 has approved the plan of thesis of **Dr.Manpreet,** a student of your college for **MD Radio-Diagnosis** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
Role of high resolution computed tomography (hrct) temporal bone in chronic suppurative otitis media

Supervisor
Dr. Ritu Dhawan Galhotra
Prof.,
Dept. of Radio-Diagnosis,
DMCH, Ludhiana.

Co-Supervisor
Dr. Archana Ahluwalia
Prof.,
Dept. of Radio-Diagnosis,
DMCH, Ludhiana.

Dr. Rohit Verma
Assoc. Prof.,
Dept. of ENT,
DMCH, Ludhiana.

The student has to submit the three copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

S P Singh

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

1. ***If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.***
2. *The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination*

ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF MEDICINE

IN

RADIODIAGNOSIS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

November, 2019

DR. MANPREET

DEPARTMENT OF RADIODIAGNOSIS

DAYANAND MEDICAL COLLEGE AND HOSPITAL

LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA
For the degree of	Radiodiagnosis
Name of the candidate	Dr. Manpreet
Supervisor	Dr. Ritu Dhawan Galhotra, Professor, Department of Radiodiagnosis, DMCH, Ludhiana
Co-supervisors	Dr. Archana Ahluwalia, Professor, Department of Radiodiagnosis, DMCH, Ludhiana Dr. Rohit Verma, Associate professor, Department of ENT, DMCH, Ludhiana
Institution	Dayanand Medical College & Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot.

Introduction: Chronic suppurative otitis media is persistent inflammation of a part or whole of middle ear cleft or mastoid cavity. It is characterised by recurrent or persistent ear discharge (otorrhoea) over 2-6 weeks. It is divided into two main clinical types: tubotympanic CSOM (chronic suppurative otitis media without cholesteatoma) that is recognized clinically as safe type and atticoantral (chronic suppurative otitis media with cholesteatoma) or unsafe type/ dangerous type(1).The diagnosis of middle ear cholesteatoma can be made simply by an otoscopic examination, in addition to endoscopic and microscopic evaluation often diagnosis may be apparent on surgical exploration .

Aim of Study: 1.To evaluate the role of high resolution computed tomography (HRCT) temporal bone in patients with chronic suppurative otitis media (CSOM) & its correlation with the clinical / operative findings wherever possible .

Materials and methods: All patients who are clinically diagnosed or suspected with chronic suppurative otitis media in ENT Department DMCH Ludhiana and are referred to the Department of Radiodiagnosis DMCH Ludhiana for HRCT temporal bone will be the participants in the study. Various parameters and observations will be recorded as per the proforma and tabulated .These findings will be compared and correlated with the intra –operative findings.

Clinical significance: The clinical significance of the study lies how accurately high resolution computed tomography scanning can define the extent and severity of the underlying disease in patients with chronic suppurative otitis media thus helping to convert a surgical exploration into a planned procedure.

Keywords: High resolution computed tomography, Chronic suppurative otitis media, intraoperative correlation.

(Signature)	(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA"** exist in the Department of Radiodiagnosis, DMC&H, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis is genuine and is collected by the candidate herself under our supervision and guidance.

Supervisor

Dr. Ritu Dhawan Galhotra
Professor
Department of Radiodiagnosis
DMCH, Ludhiana

Co-Supervisor(s)

Dr. Archana Ahluwalia
Professor
Department of Radiodiagnosis
DMCH, Ludhiana

Dr. Rohit Verma
Associate Professor
Department of ENT
DMCH, Ludhiana

Head of Department

Dr. Kavita Saggar
Professor and Head
Department of Radiodiagnosis
DMCH, Ludhiana

Place: _____

Date: _____

APPROVAL PROFORMA
BY RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr. Manpreet
Department	Radiodiagnosis
Topic of Thesis	ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA.
Likely date of appearing in PG examination	May-June 2022
Date of enrollment	1st May 2019
Name of Head of Department	Dr. Kavita Saggar
1) Supervisor **2) Co-Supervisor(s)**	Dr. Ritu Dhawan Galhotra Dr. Archana Ahluwalia Dr. Rohit Verma
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Jaspal Singh (Professor & Head, Surgery)	Mr. A K Jindal (Member, Ethics Committee)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
Dr. Sandeep Kaushal (Assistant Dean Academics)	Dr. Deepinder K Chhina (Professor & Head, Microbiology)
Dr. Rajoo Singh Chhina (Dean Academics)	Dr. Neena Sood (Professor & Head, Pathology)
Dr. Gurpreet S Wander (Vice Principal)	Dr. Gurpreet S Wander (Vice Principal)
	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / ~~No~~

Dr. Sandeep Puri
Chairperson
Research Committee

Chairperson
Research Committee

Approved: Yes / ~~No~~

Prof. Arvind Malhotra
Chairperson
Ethics Committee

Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1	NAME OF THE CANDIDATE AND ADDRESS	DR MANPREET R/O ,C/O MANJIT SINGH ,WARD NO 6,STREET NO 5 APEX COLONY DOSANJH ROAD MOGA ,PUNJAB
2	NAME OF THE INSTITUTE	Dayanand Medical College and Hospital, Ludhiana
3	COURSE OF STUDY AND SUBJECT	M.D. Radiodiagnosis
4	DATE OF ADMISSION OF COURSE	1st May 2019
5	TITLE OF THE TOPIC	ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA.

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Chronic suppurative otitis media is persistent inflammation of a part or whole of middle ear cleft or mastoid cavity. Synonyms include "chronic otitis media, chronic mastoiditis, and chronic tympanomastoiditis. It is characterised by recurrent or persistent ear discharge (otorrhoea) over 2-6 weeks. It is divided into two main clinical types: tubotympanic CSOM (chronic suppurative otitis media without cholesteatoma) that is recognized clinically as safe type and atticoantral (chronic suppurative otitis media with cholesteatoma) or unsafe type/ dangerous type.[1]

Cholesteatoma is the result of the formation of keratinized squamous epithelium in the middle ear.[2]. Cholesteatoma may be acquired or congenital, with a similar morphologic appearance .The clinical manifestations of cholesteatoma are quite variable, ranging from an asymptomatic phase to life-threatening complications [3]

The most common locations of cholesteatoma are the anterior epitympanum, posterior epitympanum, posterior mesotympanum; although they may develop anywhere within the pneumatized portions of the temporal bone.[3]

A major advance in the imaging of ear structures has occurred with the development of special imaging techniques, such as high resolution computed tomography (HRCT) which is helpful to know the extent and complications of disease in cases of CSOM with cholesteatoma (unsafe type) and can be used to complement the clinical examination.[4-6] Ossicular erosion is common in cholesteatoma, which results in poor hearing outcome this can be ascertained preoperatively by CT although CT does not distinguish soft tissue from effusion or granulation tissue.[7-8] In atticoantral type of CSOM , erosion of the scutum (the first sign of aural cholesteatoma) in the coronal view can be assessed clearly. Bone erosion occurs more commonly in the long process of the incus, the body of the incus, and the head of the malleus. Expansion of aditus ad antrum increases the probability of atticoantral CSOM. The most common site of labyrinthine fistula is the lateral semicircular canal dome; and the most involved segment of the facial nerve is the tympanic segment.[3]

The hallmarks of imaging findings on HRCT scan are based on the presence of one or more of the following: (a) nondependent soft tissue density mass associated with attic, mesotympanum or antrum, (b) typical location, and (c) bony erosion of the middle ear bony walls (ie, scutum, attic wall, tympanic spine, tegmen tympani , sigmoid sinus plate, Korner's septum, posterior and superior metal wall) erosion of the ossicles, scalloping of the mastoid, or erosion of the semicircular canal and facial nerve canal.[9]

HRCT is the imaging modality of choice in cases of CSOM for evaluation and the present study will be conducted prospectively to evaluate how accurately high resolution computed tomography scanning could define the extent and severity of the underlying disease in patients with chronic suppurative otitis media thus helping to convert a surgical exploration into a planned procedure.[10] A variety of standard surgical approaches are currently used to treat patients with CSOM. All of these procedures can be categorized as either canal wall up or canal wall down approaches.[11]

The aim of this work is to study the role, value, and impact of HRCT in detection, evaluation, and extent of disease spread in chronic suppurative otitis media.

6.2 REVIEW OF LITERATURE

Happani Hiral et al (2017) did a study on 50 patients out of which 32 were males and 18 were females. Cholesteatoma was found in 29 patients, followed by ear ossicle erosion (22 patients), mastoditis (15 patients), tympanic membrane perforation (6 patients), labyrinthine fistula (3 patients) and malignancy (2 patient). Epitympanum was involved in 29 patients followed by antrum (28 patients), mastoid air cells (22 patients), aditus (19 patients), mesotympanum (12 patients), hypotympanum (12 patients), perilabyrinthine cells (5 patients). Amongst the complicated cases, brain abscess was found in 4 patients followed by mastoid abscess (2 patients), labyrinthine fistula (1patient), facial nerve palsy (1 patient) and meningitis (1 patient).[12]

Vallabhaneni Rohit et al (2016) did a study on 50 patients diagnosed clinically with chronic suppurative otitis media (CSOM) were referred for a HRCT of temporal bone and found that .Otorrhoea (100%) is the most common symptom. Scutum was eroded in 23 cases. Incus (24 cases) is the most commonly eroded among the ossicles. Mastoiditis and mastoid abscess (20%) was the most common complication of CSOM followed by Sinus plate erosion (12%), Erosion mastoid Cortex (8%), Intracranial complications like abscess, dural sinus thrombosis (6%), Facial canal Dehiscence (4%) , Tegmen tympani Erosion (2%) , Cochlea erosion (2%) , Tegmen Erosion (2%) Lateral semicircular canal erosion(2%)Cholesteatomas were observed in 26 cases of which 9 cases were in attic, 6 cases were Attico-antral, 4 cases were in Mesotympanum, 7 cases were holotympanic. Various HRCT findings of temporal bone in chronic suppurative otitis media with cholesteatoma were Non-dependent soft tissue mass in 25 cases, Scutum erosion in 23 cases , Ossicle erosion in 20 cases , Labyrinthine fistula in 2 cases , Sigmoid sinus plate erosion in 6 cases , Mastoid cortex erosion in 4 cases , Tegmen erosion in 1 case and Mastoiditis with sub-periosteal abscess in 4 cases.[13]

Amandeep singh et al(2015) did a study with total of 50 cases, 83.33% had cholesteatoma. The surgical and radiological findings showed a high level of sensitivity (89.29%) in the identification of cholesteatoma. HRCT provides a good sensitivity of 80.65% in the identification of changes to the ossicular chain despite the presence of surrounding soft tissue.[14]

Mehrdad Rogha et al (2014) did a study on 36 patients, including 20 males (55.6%) and 16 females (44.4%), entered the study Positive surgical findings included soft tissue mass in the middle ear or mastoid (100%), ossicular erosion (80%), erosion of the scutum (76%), and aditus ad antrum widening (61%). Positive findings of the temporal bone CT scan included soft tissue mass in the middle ear or mastoid (100%), ossicular erosion (88%), scutum erosion (72%), and aditus ad antrum widening (58%). The greatest precision of CT scan in this study was in detecting sigmoid plate erosion (100%), widening of the aditus ad antrum (97.2%), and scutum erosion (94.4%).[15]

Sun XV et al (2011) did a study to evaluate the efficacy of high-resolution CT (HRCT) in differential diagnosis and treatment of chronic suppurative otitis media and cholesteatoma by soft-tissue shadows. They concluded that combination of the three different imaging methods, axial images, coronal MPR (multiplanar reconstruction) images and MIP (maximum intensity projection) images, can improve the efficacy of the HRCT diagnosis and definite chronic otitis media, which can be routinely used for surgery plan.[16]

Tatlipinar A et al (2012) did a study to determine the role of high-definition computed tomography (CT) in chronicotitis media (COM) patients and to present which parameters were useful or misleading for preoperative evaluation for management. They found out that CT could not detect dehiscence of facial canal, lateral semicircular canal, and tegmen successfully. Based on their results, they concluded that CT scanning has limitations but is a useful adjunct for the surgical management of COM patients.[17]

Yildirim-Baylan M et al (2012) did a study aimed to compare the veracity of computed tomography findings on patients undergoing surgery for chronic otitis media (COM) with the surgical findings, and to determine to what extent the preoperative computerized tomography (CT) findings are useful to the surgeon. They concluded that preoperative computed tomography evaluation is fairly useful especially in cases of cholesteatoma. According to the results of their study, CT is of value particularly in the definition of cholesteatoma, and in determining ossicular chain erosion and semicircular canal fistula.[18]

Sonika Kaotra et al(2013) did a study on 47 patients with active squamosal COM underwent preoperative HRCT temporal bone followed by surgery and

found that HRCT was highly sensitive for detecting mastoid pneumatization, soft tissue extension, ossicular erosion, tegmen and sigmoid sinus erosion, and less sensitive for fallopian canal erosion and lateral sinus fistula.[19]

Garg Payal et al did a study on 60 patients out of which in 32 patients (53.33%) cholesteatoma was found, 16 cases (26.67%) had granulation without any evidence of cholesteatoma, and 10 cases (16.67%) had cholesteatoma along with granulations. In 2 cases (3.33%) no disease was seen.[20]

Jaiprakash Tak et al did a study on 50 patients of CSOM, 26 (52%) were males. Majority of the patients (70%) were in the age group of 11 to 30 years. Left ear was involved in 40% of the patients. Majority of the patients (80%) presented with chief complaint of otorrhoea. In the present study, External Auditory Canal (EAC) was seen normal in majority of patients (82%) both radio logically and per operatively. HRCT scan was found to be very sensitive (96%) in diagnosing cholesteatoma. The sensitivity of HRCT for diagnosing disease in epitympanum, antrum and aditus was found to be 100%, 97% and 88% respectively. CT scans diagnosed erosion of malleus with 100% sensitivity and specificity and erosion of incus with 91% sensitivity and 100% specificity.[21]

Pritam Chatterjee, et al did a study on 167 patients with diagnosis of CSOM .The results of our study showed age distribution of the patients ranges from 4 to 60 years with a mean age of 23.17 years. Commonest age group was 11–20 years with 66 patients followed by 21–30 years with 41 patients. Out of all, 115 cases were male and 52 cases were female, which gives a male: female ratio of 2.21:1. Chronic ear discharge with hearing loss was the main clinical presentation (60.7 %). Extensive holo-tympanic acquired cholesteatoma was the most common, found in 89 cases (53.7 %), and followed by attic cholesteatoma, found in 29 patients (17.4 %). The scutum erosion was the most common finding, encountered in 112 patients, followed thinning of tegmen plate in 47 patients and eroded sigmoid sinus plate was found in 32 cases. The incus was the most commonly eroded, found in 120 patients, followed by malleus, found in 104. Sclerotic mastoid was the most common finding encountered in 79 %. The lateral semicircular canal fistula was the

most common finding, encountered in 39 cases. Destruction of all inner ear structures were found in 7 cases. Intact facial nerve canal was encountered in 116 patients and eroded in 51 patients. Extracranial complication included complete ossicular erosion in 104 cases, mastoiditis alone in 84 cases, automastoidectomy in 70 cases, labyrinthitis in 47 cases, LSC fistula in 39 cases facial palsy in 14, abscesses and fistula in 34 and 16 cases. Among the intracranial complication, meningitis was seen in 35, cerebellar Abscess in 21, cerebral abscess in 5, epidural abscess in 5 and sigmoid sinus thrombosis in 9 cases. The statistical analysis done based on the study was calculated.[22]

6.3 AIMS AND OBJECTIVES

1. To evaluate the role of high resolution computed tomography (HRCT) temporal bone in patients with chronic suppurative otitis media (CSOM) and its correlation with the clinical / operative findings wherever possible.

7.0 MATERIALS AND METHODS

The present study will be conducted in the Department of Radiodiagnosis and ENT for a period of 1.5 year from Dec 2019 to May 2021, in which all patients referred to the department of Radiodiagnosis for HRCT temporal bone with suspicion or diagnosis of chronic suppurative otitis media (CSOM) will be included.

A thorough clinical history will be taken from each patient regarding various symptoms like ear discharge, earache, hearing loss, fever etc.

Clinical examination of ear, nose, and throat / otoscopic findings, tuning fork tests, pure tone audiometry and laboratory investigation will be recorded. Informed consent will be taken from each patient.

Then an HRCT scan of the temporal bone will be done in all cases on 128 slice Seimens CT scanner . Findings will be recorded and tabulated according to the proforma.

Imaging findings will be compared and correlated with the clinical /intra-operative findings (wherever possible) to calculate the sensitivity, specificity, positive and negative predictive value of HRCT temporal bone by using various statistical tests.

7.1 Source of Data

The study will be conducted on patients who are clinically suspected or diagnosed with chronic suppurative otitis media in Department of ENT, DMCH Ludhiana and are referred to Department of Radiodiagnosis for HRCT temporal bone.

7.2 METHOD OF COLLECTION OF DATA

The patients diagnosed with chronic suppurative otitis media in Dayanand Medical College and Hospital, Ludhiana will be the participants in the study. The data will be collected by personal interviews / Case Registration file / Investigations done on routine basis and the investigation results. Details of past medical history, age, will be taken into consideration. Then an HRCT Temporal bone scan will be done. Findings will be recorded & tabulated and will be compared and correlated with the clinical / operative findings (wherever possible).

Inclusion criteria: Patients diagnosed or clinically suspected with chronic suppurative otitis media .

Exclusion criteria: 1. History of ear trauma.

2. Patients with suspicion of malignancy on imaging .

3. History of previous ear surgery .

4. Patients who refuse to participate in the study .

Duration of study: 1.5 year Prospective

Outcome: The study will tell us the role and accuracy of HRCT temporal bone to know the extent &severity of disease in cases of chronic suppurative otitis media .

Statistical analysis: Data will be described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate. For comparing categorical data, Chi square ($\chi 2$) test will be performed and exact test will be used when the expected frequency is less than 5.Senstivity ,specificity ,positive(predictive value (PPV) and negative predictive value .(NPV) will be calculated of HRCT temporal bone as compared to peroperative findings . A probability value (p value) less than 0.05 will be considered statistically significant. All statistical calculations will be done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

No

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Attached herewith

REFERENCES

1. Seiden AM, Tami TA, Penssak ML, Cotton RT, Gluckman JL. Otorhinolaryngology. The Essentials. New York, NY: Thieme; 2002. p. 44–58.
2. Meimanejahromi A, Hoseinnejadariani F, ArabKhani R, Hosein nejadariani Sh. Evaluation of cholesteatoma frequency in patients with chronic otitis medis. Iranian Journal of Otorhinolaryngology. 2010;22:21–4.
3. Meyer TA, Strunker JR, Chester L, Lambert PR. Cholesteatoma. In: Bailey BJ, Johnson JT. Head and neck surgery otolaryngology. 4th edition; Philadelphia, Lippincott Williams and Wilkins. 2006; 2081–91.
4. Valvassori GE, Potter GD, Hanafee WN, Carter BL, Buckingham RA. Radiology of the Ear, Nose and Throat. Philadelphia: WB Saunders; 1984. p. 222-8.
5. Virapongse C, Rothman SL, Kier EL, Sarwar M. Computed tomographic anatomy of the temporal bone. AJR Am J Roentgenol. 1982;139:739-49.
6. Zeifer B. Radiology of the temporal bone. In: Thomas R, Staecker H, editors. Otolaryngology, basic science and clinical review. 1st edition. Thieme medical publishers; 2006. p. 431-42.
7. Jackler RK, Dillon WP, Schindler RA. Computed tomography in suppurative ear disease: a correlation of surgical and radiographic findings. Laryngoscope. 1984;94:746-52.
8. Hassmann-Poznańska E, Gościk E, Oleński J, Skotnicka B. Computerised tomography in preoperative imaging of middle ear cholesteatoma. Otolaryngol Pol. 2003;57:243–9.
9. Mohammadi G, Naderpour M, Mousaviagdas M. Ossicular erosion in patients requiring surgery for cholesteatoma. Iranian journal of otorhinolaryngology. 2012;24:125-8.
10. Gaurano JL, Joharjy IA. Middle ear cholesteatoma: characteristic CT findings in 64 patients. Annals of Saudi medicine. 2004;24:442-7.
11. Datta G, Mohan C, Mahajan M, Mendiratta V. Correlation of preoperative HRCT findings with surgical findings in Unsafe CSOM. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS). 2014;13:120-5.

12. Happani H, Kalola J, Rathod H, Trivedi A. Role of HRCT Temporal Bone In Patients with Chronic Supparative Otitis Media. Radiology. 2018;3:C70-2.
13. Vallabhaneni R, Srinivasa Babu CR. HRCT temporal bone findings in CSOM: our experience in rural population of South India. IOSR J Dent Med Sci. 2016;15:49-53.
14. Thukral CL, Singh A, Singh S, Sood AS, Singh K. Role of high resolution computed tomography in evaluation of pathologies of temporal bone. Journal of clinical and diagnostic research: JCDR. 2015;9:TC07-10.
15. Rogha M, Hashemi SM, Mokhtarinejad F, Eshaghian A, Dadgostar A. Comparison of preoperative temporal bone CT with intraoperative findings in patients with cholesteatoma. Iranian journal of otorhinolaryngology. 2014;26:7-12.
16. Sun XW, Zhang JJ, Ding YP, Dou FF, Zhang HB, Gong KB, et al. Efficacy of high-resolution CT in differential diagnosis of chronic suppurative otitis media and cholesteatoma otitis media by soft-tissue shadows. Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 2011;46:388-92.
17. Tatlipinar A, Tuncel A, Öğredik EA, Gökçeer T, Uslu C. The role of computed tomography scanning in chronic otitis media. European Archives of Oto-Rhino-Laryngology. 2012;269:33-8.
18. Yildirim-Baylan M, Ozmen CA, Gun R, Yorgancilar E, Akkuş Z, Topcu I. An evaluation of preoperative computed tomography on patients with chronic otitis media. Indian J Otolaryngol Head Neck Surg. 2012;64:67-70.
19. Kanotra S, Gupta R, Gupta N, Sharma R, Gupta S, Kotwal S. Correlation of high-resolution computed tomography temporal bone findings with intra-operative findings in patients with cholesteatoma. Indian Journal of Otology. 2015;21:280-5.
20. Payal G, Pranjal K, Gul M, Mittal MK, Rai AK. Computed tomography in chronic suppurative otitis media: value in surgical planning. Indian Journal of Otolaryngology and Head & Neck Surgery. 2012 1;64:225-9.
21. Tak J, Khilnani AK. Role of high resolution computed tomography of temporal bone in management of chronic suppurative otitis media. Indian J Otolaryngol Head Neck Surg. 2016;2:1-9.

22. Chatterjee P, Khanna S, Talukdar R. Role of High Resolution Computed Tomography of Mastoids in Planning Surgery for Chronic Suppurative Otitis Media. Indian J Otolaryngol Head Neck Surg. 2015;67:275–80.

PROFORMA

SR No-

NAME -

AGE/SEX-

CR NO -

ADDRESS-

TEL.NO –

Clinical history

Chief Complaints :-

- Ear discharge (otorrhoea) :
  a) side
  b) foul odour
  c) continuous / intermittent
  d) relation to upper respiratory tract infection
- Hearing loss :
  a) mild -
  b) moderate-
  c) severe -
- Ear ache (otalgia):
  a) character
  b) intermittent
- Headache
- Fever
- Vertigo
- Tinnitus
- Post auricular swelling
- Facial weakness
- Others

Signature of Candidate **Signature of Supervisor**

PAST HISTORY –

FAMILY HISTORY -

PERSONEL HISTORY–

Clinical examination:

1. Otoscopic findings :

2. Examination under otoendoscopy / microscopy –

3. Tuning fork tests :
   a) Rinne's test
   b) Weber's test
   c) Absolute bone conduction

4. Hearing loss – Right Left
a) Conductive
b) Sensorineural
c) Mixed

General physical examination:

Pulse -

Blood pressure-

Temperature-

Respiratory rate-

Relevant investigations:

Signature of Candidate **Signature of Supervisor**

Clinical diagnosis:

CT Findings

- External auditory canal
- Retraction of TM
- Soft tissue Mass present
- Displacement / erosion of ossicular chain(malleus , incus and stapes)
- Erosion of scutum
- Aditus ad antrum
- Dehiscence of tegmen tympani
- Opacification of mastoid air cells
- Erosion /sclerosis of mastoid bone
- Facial canal dehiscence
- Erosion of sigmoid sinus plate.
- Lateral semicircular canal dehiscence
- Any other complications

PEROP FINDINGS:

FINAL DIAGNOSIS:

Signature of Candidate **Signature of Supervisor**

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o..... .....am willing to participate in the study **"ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA "** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____ निवासी _____ इस शोधकार्य **"ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA "** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) TEMPORAL BONE IN CHRONIC SUPPURATIVE OTITIS MEDIA " ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ